POWER

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His Farewell Advice

In a certain power station was an old gray-haired engineer, who by close application to his job had slowly worked up to the position of Turn Chief. He was a fine old man, one in whom the young engineer soon found a friend, and of a quiet, unassuming manner that commanded respect. He was, in fact, a "dad" to all the youngsters in the service.

There was a genuine feeling of regret, therefore, when a notice appeared on the bulletin board stating that Mr. Blank would assume the duties of Turn Chief and that the old engineer would be pensioned. During the noon-hour, after lunch was over, the crew congregated around the old chief, and one of them let fall a question.

"Chief," said he, "what would you do to win success if you could by magic start all over again in power-station work? In other words, what would be your motto for the apprentice in this line?" The old chief removed his glasses, carefully placed them in their case and pondered a moment before he attempted to answer.

"Well, boys," he remarked, "lack of concentration is to blame for many a failure. I mean that you have to be conscientious in your effort to learn your trade. You have to be positive that you are making the kind of progress that will get results. You cannot guess at your progress—you have to be sure. None of you would attempt to set the valves on your engines without the aid of an indicator; so to be absolutely sure that you are obtaining the desired results in your effort to attain efficiency as an engineer, suppose you use your indicator—your own conscience. Be honest with yourself—take a few cards and find out for certain whether your results are consistent with your ambition.

"It doesn't pay to do a thing by halves, no matter if it is only the repair of a leaky joint on a small steam pipe. Concentrated action is the cure-all—it saves doing it over again tomorrow

"I recall an incident that occurred when I was still young in this business. My stock in trade consisted of about ninety per cent. conceit and ten per cent. adaptability. Like most of the fellows of my age, I took the world as a big joke. Along about that time a world-famous prize fight was pulled off, and incidentally I was much interested. The next day after the big mill the chief engineer told me to go over the valves on a large Corliss engine and to make any changes necessary.

"Now it was the duty of the regular operating engineer to assist me on such work. We put on the indicator rigging, but during our preparations we got into an argument about the prize fight. The relative merits of the two fighters absorbed our minds to such an extent that we argued all the time we worked on that unit. So, by noon we had discussed the fight pro and con and also had completed the work on the engine.

"We got a set of cards that we thought would make the chief take notice—and they did! He went up in the air and came down all over us, the more so when the switchboard operator called attention to the fact that the engine was gradually losing her load. We hadn't indicated the steam engine as much as we had indicated the prize fight, with the result that we left some locknuts loose, and the link-rods nearly wrecked the engine when they fell apart. If there was any reason for our fool conduct, it was conceit, for we had indicated that engine so often that we could do it with our eyes shut—which was exactly what we did. We were both blind to the value of concentration.

"You must bear in mind that it is often the minute details, properly taken care of, that make your record. Concentrate your effort—either mental or physical—along one line. While I have no grievance against the world, lack of concentration is one of the big reasons why I was so long in climbing up the hill. I was much older than most of you fellows when it dawned on me to wake up and take an inventory. I did, with the result that I put more real purpose into my work. And along about that same time the 'bosses' began to put confidence in me. Mottoes are going out of fashion, it seems. But if you want a first-class slogan—you young lads who have the entire fight ahead of you—here it is: ***Concentrate!***"

Contributed by JAMES J. JAHOBART

New Power Plant for St. Mary's Training School

A small plant of varied service well adapted to the requirements of the institution. Moving some of the equipment from the old to the new plant while maintaining service was the source of numerous difficulties. Revamping the water supply made an interesting problem.

ST. MARY'S Training School, one of the largest Catholic institutions in the West, offers a home for a thousand small unfortunates, giving them the advantages of healthy living conditions, coupled with moral and mental training. The institution is beautifully situated overlooking the river at Des Plaines, Ill.

The larger boys are instructed in useful work, tilling the ground and harvesting the crops. The children are given industrial training in housework, sewing, manual training, shoemaking, printing and many other useful lines of endeavor. As the maintenance of healthy housing and living conditions is a necessity in an institution of this kind, particular care and attention was given to the various mechanical services related to the power plant. As in the case of many institutions where the growth has been rapid, the power-plant equipment had become antiquated and inadequate. The machinery had been badly used on account of continual overload and lack of proper relays. After an investigation of plant conditions made in May, 1916, it was decided to build an entirely new plant. As the old building was not suitable for the new equipment and the old apparatus had to be kept in continuous service, a new location was selected.

In the old plant there were four 72-in. x 18-ft. tubular boilers with hand-fired furnaces and shaking grates, operated at 110 lb. pressure. They were in bad condition on account of the use of poor water during the period prior to the installation of a water-softening plant. The generating equipment comprised two high-speed engines directly connected to 75-kw. 125-volt direct-current generators. All power and light distribution for the institution was at 120 volts. The refrigerating system was served by an ammonia compressor having an ice-making capacity of 12 tons. The brine was circulated throughout the service building for refrigerators and ice making.

Much of the heating was effected by forced hot-water circulation. Two heaters were installed to care for this service—an exhaust-steam heater approximately 8 ft. in diameter by 22 ft. high, equipped with iron tubes, and a high-pressure heater 6 ft. in diameter by 15 ft. high. Two turbine-driven centrifugal pumps, each having a capacity sufficient to serve 35,000 sq.ft. of radiation, were used to circulate the hot water. The chapel, convent and power-house group of buildings were on a vacuum system containing approximately 6500 sq.ft. of radiation. Two 5 & 6 x 10-in. vacuum pumps handled the returns.

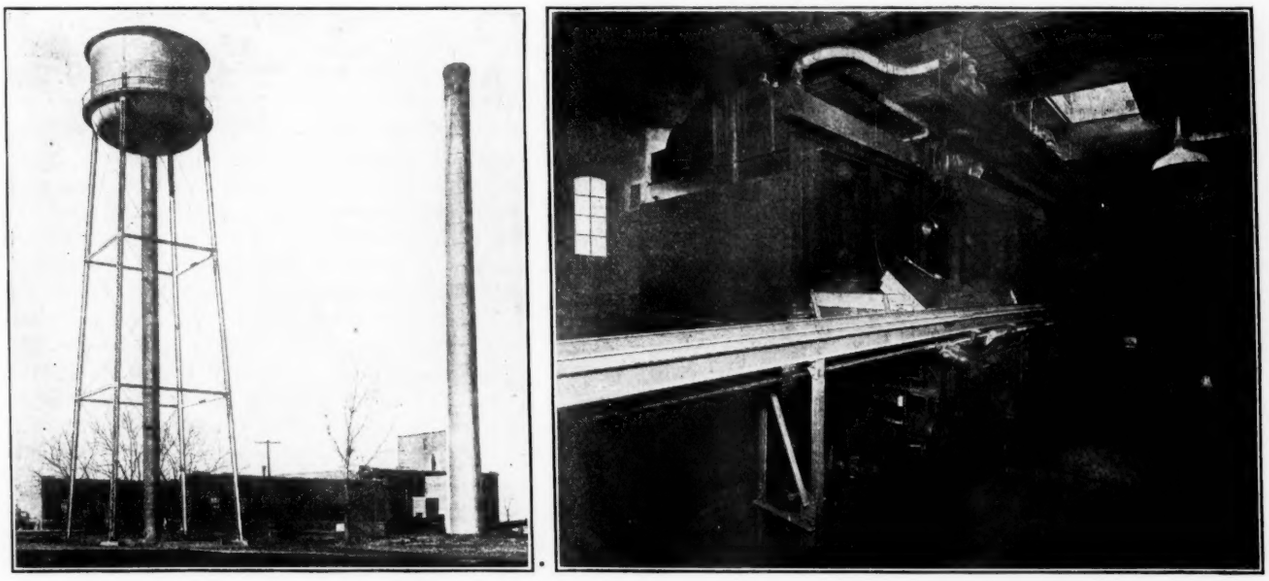
Water softening by the cold intermittent process was effected by a softener consisting of four wooden tanks, 15 ft. in diameter by 12 ft. high, with two sludge filters 4 ft. in diameter by 4½ ft. high. A 7½ & 5 x 6-in. duplex pump transferred the water from the softener to the treated-water tank in a brick tower adjoining the boiler room. From this tower treated water was distributed to the laundry, hot-water heaters for domestic service and to the feed-water heater for boiler-feed service. A 6 & 4 x 6-in. duplex pump circulated the domestic hot water, and two direct-acting pumps in connection with an open feed-water heater were used for boiler-feed service. A straight-line steam-driven air compressor having a displacement of approximately 150 cu.ft. of air per minute provided air at 45 lb. pressure for lifting the drinking water from a driven well and delivering it to a direct-acting pump, by which it was circulated throughout the institution. A 16 & 7 x 12-in. pump taking its suction from the large steel house tank provided fire protection. Two tank heaters with steam coils and one hot-water heater having a capacity of 1350 gal. per hour were used for hot-water service. All the pumps and equipment were in bad repair. The heaters on the heating system leaked so badly as to require constant renewal of the circulating water. The domestic-water heaters showed indications of heavy scale deposit. In the generating room one of the engines had a sprung shaft.

The general water supply was taken from the Des Plaines River, a reservoir being located approximately 2000 ft. from the power house. Adjoining this reservoir was installed a submerged centrifugal pump with vertical shaft, driven by a 75-hp. direct-current motor. The pump capacity was approximately 700 gal. per min. The discharge line of this pump was carried underground to a large steel tower of approximately 20,000 gal. capacity. From this tower connection was made to the water-softening plant and also to two domestic filters. From the latter lines were carried up to separate open surge tanks located in and supplying the various buildings with cold domestic water.

As the Des Plaines River is contaminated with sewage, the menace of this general water supply can be understood. Although the institution is served by drinking water taken from the deep well, there was no assurance against the help or children using the general water supply for drinking under certain occasions. In revamping the plant such an alternative was made impossible.

In equipping the new plant, it was necessary to keep the present equipment in operation without interrupting the service while changing over from the old to the new building. On account of the value of certain of the old equipment some of it was moved to the new plant after putting it in satisfactory operating condition, so that the selection and arrangement of the new apparatus had to be considered carefully to maintain satisfactory service.

The new power-house building, including boiler room, pump room, engine room, refrigerating room and general service rooms, was built to the north of the old plant. A tunnel about 150 ft. long extends from the pump room to the old boiler room. The tunnel is about



POWER PLANT AND PRESENT BOILER INSTALLATION OF ST. MARY'S TRAINING SCHOOL.

8 ft. wide and 9 ft. high, giving ample space for piping and permitting access from one building to the other. The boiler room had to be located conveniently to the spur track to permit delivery of coal in carload lots.

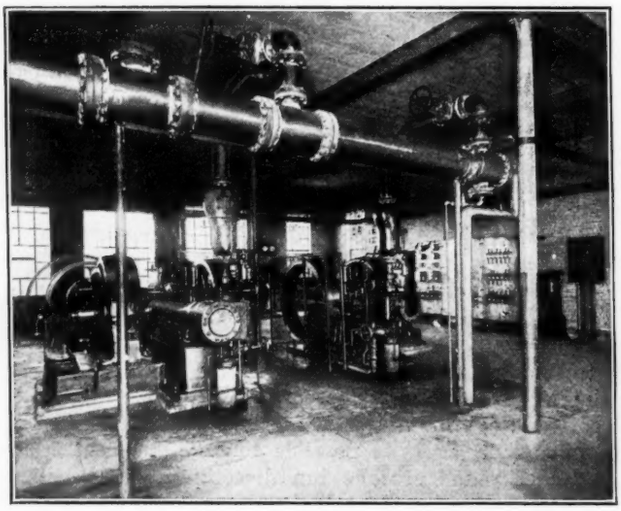
In the new boiler room the floor is approximately eight feet below grade. It is equipped with three 390-hp. Stirling boilers with space for one more, built for a working pressure of 160 lb. but operated at 110 lb. Top-feed stokers provided with extension furnaces serve the three boilers. The chimney is 8 ft. 6 in. in diameter by 175 ft. high.

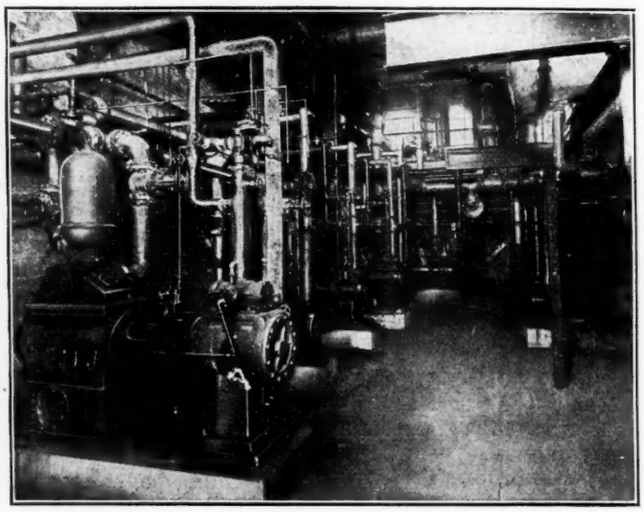
Coal is delivered from bottom- or side-dump cars into a large storage bin below the tracks and at the front of the boilers. The bottom of this hopper is on a level with the boiler-room floor line and has doors into the boiler-room space, so that if the occasion warrants the coal may be transferred by hand to the stoker hoppers. Normally, the coal is conveyed through spouts from the under side of the track hopper to a scraper conveyor in the ash tunnel below the boiler-room floor. This conveyor carries the coal to a vertical bucket hoist that in turn dumps it into an overhead storage bin of approximately 50 tons capacity. This bin is directly above an industrial track resting on the top of the extension furnaces. From this point the coal is transferred to the stokers by means of an industrial car. As the tops of the furnaces are in line with the grade, a door is provided at the north end of the boiler room and an extension track carried out to an extensive coal-storage yard served by the spur track previously mentioned.

The ash spouts down to the same scraper conveyor that handles the coal and is elevated by the same vertical conveyor to a separate ash storage bin directly over the spur track, permitting discharge into the railway cars bringing in the coal. The conveying equipment has a capacity of approximately 25 tons per hour. The system is convenient, as it is possible to take the coal from the underground storage bin directly into the boiler room in case of accident to the conveyor, and the extension track permits coal to be transferred directly from storage to the stokers. In institutions of this kind isolated from general centers of distribution, ground storage of coal is essential to tide over delays in shipments, particularly during the winter period, when power requirements are heavy.

It was deemed advisable to use the old generating equipment, which had ample capacity to serve the institution. One engine was shut down, repaired and then moved over into the new plant. After this unit was in successful operation and the necessary temporary wiring connections to the old switchboard had been made, the second unit was revamped and moved over. Space was left in the engine room for the installation of one or more units to care for possible future growth.

The old switchboard was moved also, one panel at a time, and installed in the new engine room. On account of the expense of carrying the individual feeder lines through the tunnels to the switchboard in its new location, one main feeder line was run through the tunnel and connected to the branch lines in their original locations. At this point separate remote-control switches were installed for each feeder, control wires being carried back to the switchboard.





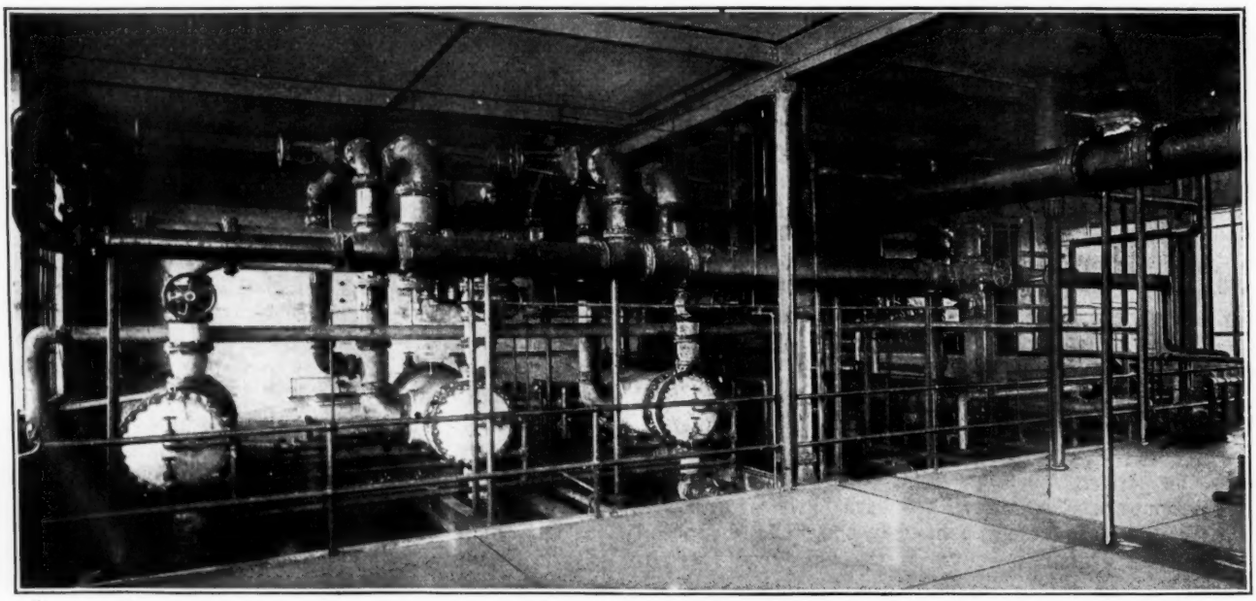
ENGINE-ROOM EQUIPMENT AND PUMPROOM AT BOILER-ROOM LEVEL

The pump room is on a level with the boiler room, eight feet below the engine room. There is no division wall, however, so that the pumps are under the observation of the operating force in the engine room. In this room are located the various pumps serving the installation, together with the old air compressor and the turbo-driven centrifugals for the hot-water heating system. The feed-water heater and the domestic hot-water heaters are on a platform about three feet higher than the engine-room floor. The piping tunnel connecting the two plants enters the pump room. The distributing piping and wiring are carried through this tunnel with the pipes either swung from the ceiling or suspended on the side walls.

The Refrigerating Service

In a room adjoining that provided for the generating equipment are the brine-circulating pump, condenser, ice-making tank and a large ice-storage refrigerator, the ammonia compressor being installed in the engine room. All the brine-circulating lines drop into the tunnel from the ice-making room and continue to the boxes in the main service building. An engineer's office, storeroom, toilet and locker rooms adjoin and are on the same level as the engine room.

On account of the condition of the old heaters on the heating systems and also taking into account the fact that the heating system would have to be kept in operation during construction, it was deemed advisable to install new hot-water heaters. The total heating load on the forced hot-water system is at present approximately 70,000 sq.ft. Three two-pass heaters were installed, each having 316 three-quarter-inch tubes 6 ft. long and being capable of heating 35,000 lb. of water per hour from a temperature of 160 deg. F. to 180 deg. F. when provided with steam at atmospheric pressure. The two turbine-driven centrifugal circulating pumps were put in condition and moved over to the new plant, one being maintained in operation in the old plant until the entire heating system was changed over to the new equipment. The second pump was then moved to its new location. Space was left for two additional heaters of the same capacity to provide for future extension.



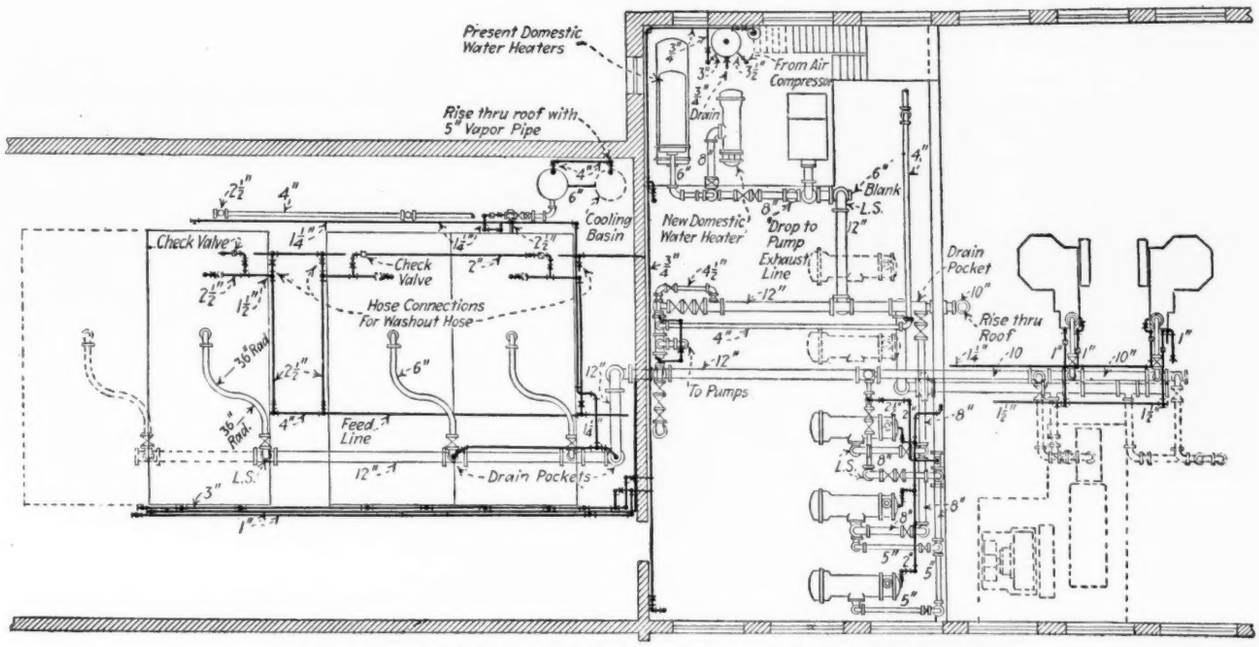
HEATERS FOR FEED WATER AND DOMESTIC SUPPLY LOCATED ABOVE PUMPROOM.

Two of the hot-water heaters are connected to the exhaust system, and one is connected to the auxiliary high-pressure steam system. The heaters are connected up in parallel, and the piping is so valved that any one or all can be operated on the system at one time. The water temperature is maintained by means of thermostatic control.

Two vacuum pumps are installed to handle the condensation from the hot-water heaters and also to care for the vacuum system previously mentioned. These pumps discharge into a standpipe that connects with the feed-water heater.

Revamping and changing of the water supply was one of the most interesting features of the work. The drinking water for the school was obtained from a 100-ft. driven well. The water is forced to the surface by compressed air and discharged into a large reservoir. From this reservoir the old drinking water pump forced the water through a pressure system to the various faucets throughout the building. The supply from this well was not adequate, and a new 1600-ft. well was sunk at a point adjoining the power house, with a concrete brick-lined reservoir built as a part of the system.

As previously mentioned, the contaminated river water had been used for general domestic purposes other than for drinking, the supply coming from the Des Plaines River. It was considered inadvisable to use this water when it was determined that the new well



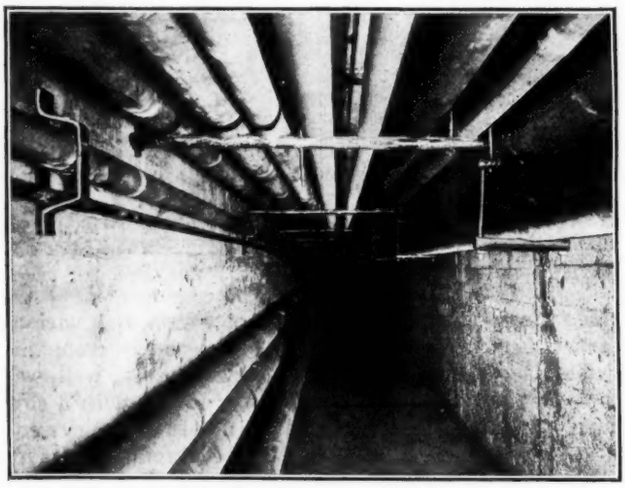
STEAM AND EXHAUST PIPING ST. MARY'S SCHOOL POWER PLANT.

PRINCIPAL EQUIPMENT OF ST. MARY'S POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
3	Boilers	Stirling	390-hp.	Generate steam	110-lb. steam, natural draft, stokers	Babcock & Wilcox Co.
3	Stokers	Top-feed	64 sq.ft.	Serve boilers		American Foundry & Casting Co.
1	Chimney	Concrete	8 ft. 6 in. by 175 ft.	Natural draft for boilers		General Concrete Construction Co.
1	Conveyor	Scraper	25 tons per hr.	Coal from track hopper to bucket elevator	Motor-driven	Link-Belt Co.
1	Elevator	Bucket	25 tons per hr.	Coal to overhead bunker	Motor-driven	Link-Belt Co.
1	Industrial car	Side-dump	27-cu.ft.	Coal to stoker hoppers		Link-Belt Co.
1	Pump	Simplex	14x9x12-in.	Boiler-feed water	110-lb. steam	American Steam Pump Co.
1	Pump	Simplex	12x8½x12-in.	Boiler-feed water	110-lb. steam	American Steam Pump Co.
1	Pump	Simplex	10x6x12-in.	Boiler washout	110 lb. steam	American Steam Pump Co.
1	Heater	Open	48,000 lb. per hr. from 150 to 210 deg. and 5,000 lb. per hr. from 60 to 210 deg.	Feed water	Exhaust-steam	Warren Webster & Co.
3	Heaters	Closed	380-sq.ft.	Hot-water heating system	Each 35,000 lb. water per hr. from 160 to 180 deg.	Alberger Heater Co.
2	Pumps	Centrifugal	1,500-g.p.m.	Circulate hot water for heating	Turbine-driven	De Laval Steam Turbine Co.
1	Softening plant	Cold-process	4,000-g. per hr.	Soften well water	Sludge filters	Pittsburgh Filter Co.
1	Heater	Instantaneous	6,000-g.p.h. from 60 to 180 deg.	Domestic hot water		Alberger Heater Co.
2	Heaters	One U-tube, one storage-type	2500-g. per hr., 1,000-g. per hr.	Domestic hot water		Berryman
1	Pump	Simplex	14x10x12-in.	Treated water pump	110-lb. steam	American Steam Pump Co.
2	Pumps	Simplex	10x8x12-in.	Drinking water	110-lb. steam	American Steam Pump Co.
1	Pump	Centrifugal	2-in.	Domestic hot water	Motor-driven	American Steam Pump Co.
2	Pumps	Vacuum	10x12x12-in.	Vacuum-heating system	110-lb. steam	American Steam Pump Co.
1	Pump	Underwriters	16x9x12-in.	Fire and general service	110-lb. steam	Worthington Pump & Mach. Corp.
1	Air compressor	Straight-line	386 cu.ft. at 250 r.p.m.	Air-lift	110-lb. steam, 45-lb. air	Ingersoll-Rand Co.
1	Air compressor	Straight-line	150 cu.ft.	Air-lift	110-lb. steam, 45-lb. air	Chicago Pneumatic Tool Co.
2	Engines	Simplex high speed	13x12-in.	Generating units	Noncondensing, 250 r.p.m., 110 lb. steam	Ames Iron Works
2	Generators	Direct-current	75-kw.	Generating units	125-volt, direct-connected	Sprague Electric Works
1	Compressor	Ammonia	8½x12½ in., 12-ton ice-making cap.	Refrigerating plant	Motor-driven	Fred W. Wolfe
1	Condenser	Double-pipe	20 pipes, 20 ft. long	Refrigerating plant		Kroeschell Bros. Ice Machine Co.
1	Combination brine and ice tank		20 ft. long, 10 ft. wide, 3 ft. high	Brine cooling and ice making		Kroeschell Bros. Ice Machine Co.
1	Pump	Simplex	8x7½x12-in.	Brine circulating	110-lb. steam	American Steam Pump Co.

would give a flow of approximately 350 gal. per min., which, coupled with the flow from the old 100-ft. well, was sufficient for the entire needs of the institution.

Abandoning the old system proved to be a happy solution, as it eliminated the load due to the 75-hp. motor at the river and eased off considerably on the service required of the relatively small generating equipment. It also did away with the trouble experienced with the 112-volt direct-current transmission line to the motor. The river pumping plant was shut down and the new deep well made ready for service. An underwriters' fire pump having a capacity of 750 gal. per min. transferred the water from the reservoir of the deep-well system into the steel tower. From this point the water went to the softening plant, supplying also all of the domestic cold water. The fire pump was connected to the fire line and cross-connected on its suction with the old river-water system, so that if the deep well failed to give sufficient water for fire protection



METHODS OF SUPPORTING PIPE IN TUNNEL

the fire pump could be thrown automatically on the river supply, though normally operating on the deep well.

Being absolutely clear, the deep-well water obviated the necessity of the two domestic-water filters that had to be used when the supply was taken from the river. These filters were installed in conjunction with the softening plant to provide the needed increase in filtering capacity. The water treatment had to be changed to some extent, as the deep-well water ran about 22 grains per gallon as compared to 16 grains for the river water. The operation of the system, however, was more satisfactory, as the deep-well water was of constant hardness while the river water was continually changing owing to dilution after heavy rains.

It was necessary to operate the drinking-water pumps and in addition install two more pumps to provide a reserve for this service. These pumps can take their suction from either as conditions require. A new compressor having a capacity of 386 cu.ft. per min. at 250 r.p.m. was installed as a relay to the old compressor.

For the boilers a new feed pump was installed to operate in conjunction with the two older pumps, one of the latter being connected up for boiler washout purposes. An additional domestic hot-water heater of the instantaneous type having a capacity to heat 6000 gal. of water per hour from 60 deg. to 180 deg. with steam at atmospheric pressure was provided. The heater contains 128 three-quarter-inch tubes 6 ft. long arranged for four passes. The installation also included a special feed-water heater of the open receiver type, capable of heating 48,000 lb. of water per hour from 150 deg. to 210 deg. and 5000 lb. of water per hour from 60 deg. to 210 deg. This combination heater was called for, as much of the water was condensation returned from the hot-water heaters at a temperature approximating 150 deg. The 5000 lb. of water raised from 60 deg. to 210 deg. was the approximate estimate of the makeup water required for the system.

Many unforeseen difficulties arose during construction, particularly in changing over from one plant to the other. This work, however, was accomplished without interruption of the service. The refrigerating plant was moved during the winter and placed in operation in sufficient time to renew the service in the spring. Sufficient space has been left to permit doubling the boiler capacity at any future time. The equipment is well protected by relays, and the size is such as to permit carrying double the present loads. The new power plant is well adapted to the uses of this particular institution. The engineering work, including the building, was designed by Neiler, Rich & Co., of Chicago, who had entire charge of all the work involved in the project.

Water-Power Development in Europe

It is said that the water power of Bavaria is capable of generating 809,100,000 kw.-hr. annually. It is proposed to utilize this power and augment it by means of steam installations to the extent of 162,900,000 kw.-hr., combining the supplies in one network. The estimates for the scheme give the capital cost as £14,195,000 ($69,072,870) and an annual expenditure of £1,682,500 ($8,181,045.)

In a paper on "Water Power Development," read before the Royal Society of Arts, Prof. A. H. Gibson recently remarked that when it is realized that the total industrial requirements of the world at present, excluding shipping, amount only to about 95,000,000 hp., involving, however, under present conditions, the consumption of some 600,000,000 tons of coal per annum, and, moreover, that this is not continuous power, but is in general utilized only for some 3000 hours per annum, it is evident the water power of the Empire, if efficiently utilized, would be sufficient in amount to perform the major portion of the world's industrial work, and that this water power is bound to be a powerful factor in determining the economic destiny of the Empire.

Among the various European countries that have lately been giving special attention to the development of water power, France is one of the most progressive. In that country approximately 850,000 hp. has been put into operation or into development since 1915. In Italy concessions involving about 300,000 hp. are already under way or are being considered. In Iceland one scheme involving the development of over 1,000,000 hp. is in contemplation. In Spain various large projects, including one estimated to give 350,000 hp., are under consideration. In Japan many projects are in course of development. In Austria and Russia, in spite of the disturbed conditions, considerable attention is, according to all reports, being paid to hydro-electric developments, particularly in the former country, with reference to the electrification of railways.—*The Engineer*, London.

Single-Phase Load on a Two-Phase System

By J. B. Gibbs
Engineer Transformer Department The Westinghouse Electric & Manufacturing Company

THE best way to connect a single-phase load to a two-phase generator is to divide the load into two equal parts and connect one of the parts to each phase of the generator, as shown in Fig. 1. This gives a balanced load on the generator and the best possible conditions in the line and transformers. For this connection two transformers are needed having a combined rating equal to the load.

If the single-phase load cannot be divided, and if it is small in comparison with the power system, it is usually best to connect it to one phase of the two-phase system and not try to balance the two phases. Such a load requires one transformer having a rating equal to the load. Large power systems usually have numerous small single-phase loads which are scattered so that the phases are approximately balanced.

If the load is large in comparison with the generator, an advantage may be gained by connecting as shown in Fig. 2. Two transformers are needed. The primary of the first is connected to one phase of the generator and the primary of the second to the other phase. The two secondaries are then connected in series. The single-phase voltage delivered to the load may be found as follows:

The voltage of the first transformer is 90 deg. out of phase with the voltage of the second. This means that

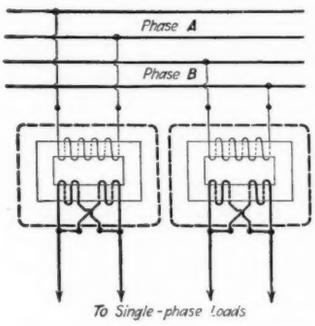


FIG. 1. TWO SINGLE-PHASE LOADS ON A TWO-PHASE SYSTEM

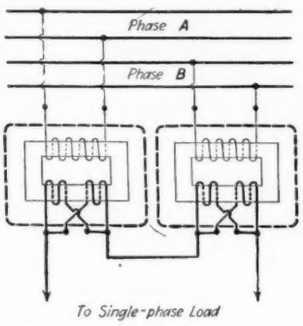


FIG. 2. ONE SINGLE-PHASE LOAD ON A TWO-PHASE SYSTEM

at the instant when the alternating voltage on the first transformer is passing through its maximum value, the voltage on the second is passing through its zero value. These two voltages may be represented by vectors, as in Fig. 3. OE_1 is drawn of a length proportional to the voltage delivered by the first transformer, and OE_2 is drawn at right angles to OE_1 and of a length proportional to the voltage of the second transformer. If two similar transformers are used, the lengths of OE_1 and OE_2 will be the same, since the two secondary voltages are equal. Both these voltages act on the load, and therefore the single-phase voltage will be the resultant of the two. Complete the square as shown by the dotted lines and draw the diagonal OD. This will represent the single-phase voltage. If OE_1 and OE_2 be taken as 100 per cent. the resultant will be the hypotenuse of a right triangle and will be equal to

$$OD = \sqrt{(100\ per\ cent.)^2 + (100\ per\ cent.)^2}$$
$$= 141.4\ per\ cent.$$

For example, if the secondary voltage of each transformer is 110 volts, the resultant single-phase voltage will be $110 \times 1.414 = 155.5$ volts.

If the same two transformers were similarly connected to a single-phase line, they would deliver the same current at a voltage of $110 + 110 = 220$ volts. The connection to the two-phase line, therefore, takes transformers having a rating $\frac{220}{155.5} = 1.414$ times as large as the load. Usually, the resultant single-phase voltage will have to be changed to one of the standard voltages, such as, 110 volts, 220 volts, etc., by means of another single-phase transformer or an auto-transformer.

The effect of a single-phase load connected in this way to a two-phase generator is to set up an armature reaction which will raise the voltage on one phase of the generator and lower it on the other. In extreme cases, where the single-phase load is large compared with the generator rating, this unbalance may amount to from 10 per cent. to 20 per cent.

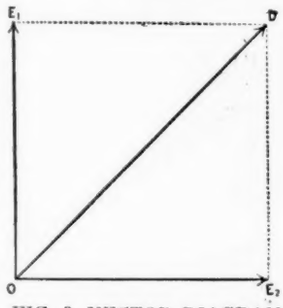


FIG. 3. VECTOR DIAGRAM OF TWO-PHASE VOLTAGES

It has been pointed out by B. G. Lamme that one single-phase load can never give a balanced condition in a polyphase system, for the reason that single-phase power is pulsating while polyphase power is continuous. To get a balanced load, therefore, it is necessary to have something with a flywheel effect to take up the pulsations.

Summing up the foregoing, it is seen that a single-phase load can be connected to a two-phase power system in several ways:

1. It may be divided into two equal parts and connected separately to the two phases. This requires two transformers with a combined rating equal to the load and is the best method.

2. A small single phase load may be connected to one phase of the system, using one transformer whose rating is equal to the load.

3. It is sometimes advantageous to connect a large single-phase load across both phases of the two-phase system. This requires two transformers having a total rating equal to 1.414 times the load. In addition these transformers must have a special voltage ratio, or else an additional single-phase transformer or auto-transformer must be used.

4. No one single-phase load can produce a balanced condition in a polyphase generator.

The proposed bridge across the Mississippi River at Minneapolis will have the longest reinforced-concrete arch in the world. The present longest is the Risorgimento Bridge at Rome, 328 ft. long. The Minneapolis bridge will have a center span of 400 ft., two side spans of 200 ft., and two end spans of 60 ft.

TYPICAL FRONT VIEW OF HOLTWOOD TRANSFORMER

In addition to the usual fittings and attachments furnished by the manufacturer, note the submerged-bulb-type oil thermometer with round dial mounted at man's height to the left; thermometers in ingoing and outcoming water manifold; the danger sign on top of transformer, mounted on a swivel in locked position; red and green automatic signal lamps indicating closed and open positions of low- and high-tension switches, located on the left of the compartment.

Operation at Holtwood

CARING FOR THE MAIN TRANSFORMERS

By

Charles H. Bromley

How the transformers are cleaned and inspected. Cleaning the cooling coils. Testing, Sampling the transformer oil.

THE transformers (see the headpiece) are practically under continuous surveillance. The operators are always watching the load distribution on the various transformers, watching the temperatures and water flow, and are keen to any change in the musical hum of the transformers which would indicate an abnormal operating condition. Readings of transformer load, oil temperature and incoming and outgoing water temperatures are taken every hour and recorded. If there is an abnormal difference in the temperature between the incoming and outgoing water when the flow of water is normal and the transformer is not overloaded, it means that the cooling coils are clogged and must be cleaned as described below.

The entrance bushings and transformer tops are cleaned and inspected weekly. At this time the loads, both high- and low-tension, and the insulators are cleaned and felt to ascertain if the insulating supports are rigid or loose. The reactances are cleaned and inspected monthly. Loose bolts and shrinkage of wooden filler pieces are looked for.

The neutral ground stacks (see Fig. 2) are cleaned and inspected every three months, at the time of the high-tension bus inspection. The stacks are carefully watched for broken grids and loose connections. Other than the regular inspection, the stacks are examined after each time that ground current has passed through them. Satisfactory operation of the arc extinguisher, interlocking relay and field relay depend upon these stacks. An open-circuit or other fault, besides crippling the relay protecting system, may cause violent arcing, possibly on the high-tension bus itself. In the event of ground current on the high-tension side not being promptly cleared by the relays, the transformer grids may become red-hot and sag sufficiently to short-circuit one another during a subsequent ground.

Cooling Coils—Once a month the cooling coils are blown out with air at 100 lb. pressure to remove sediment. One coil at a time is blown out. This is done by closing the main water-supply valves and valves to the individual coils, admitting air pressure to the manifold; the air blows out the coil that is open. Each coil is blown out three times at least, but before blowing each time it is first filled with water.

The insulation resistances of the high-tension winding to ground, low-tension winding to ground and high-tension winding to low-tension winding are measured annually. Each year there is made a high-potential test of 15,000 volts on the low-tension side for one minute.

Sampling and Testing Transformer Oil—A sample of oil is drawn from each transformer every month. Glass bottles for the purpose are provided. Each transformer has its own bottles, the use of which for other transformers is forbidden. The first quart or two of oil drawn from the bottom of the transformer is used for rinsing the bottle and then discarded. The bottle is then filled to overflowing, and is sealed and tagged.

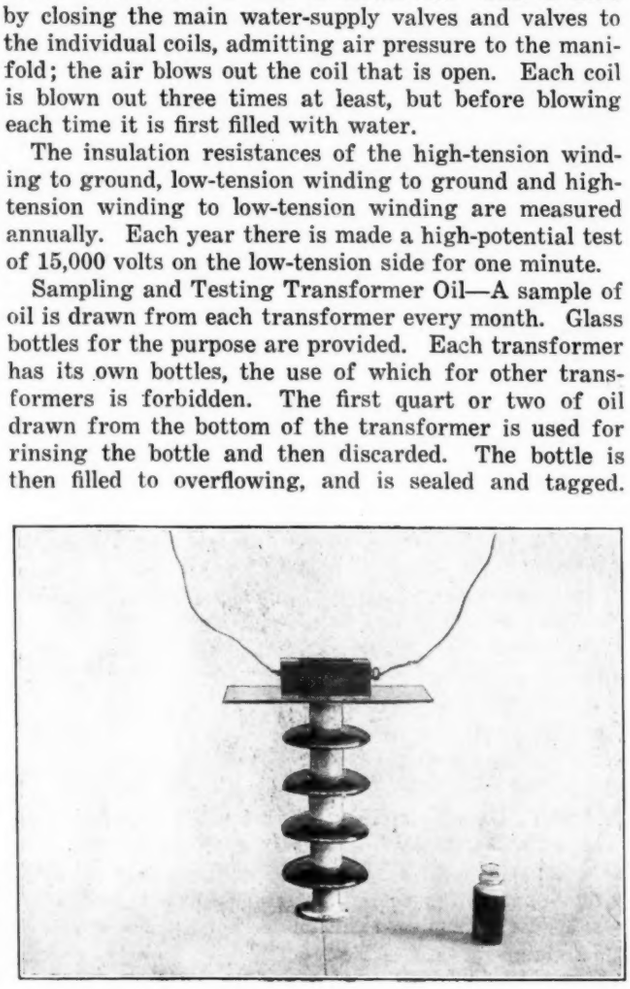


FIG. 1. TESTING TRANSFORMER OIL

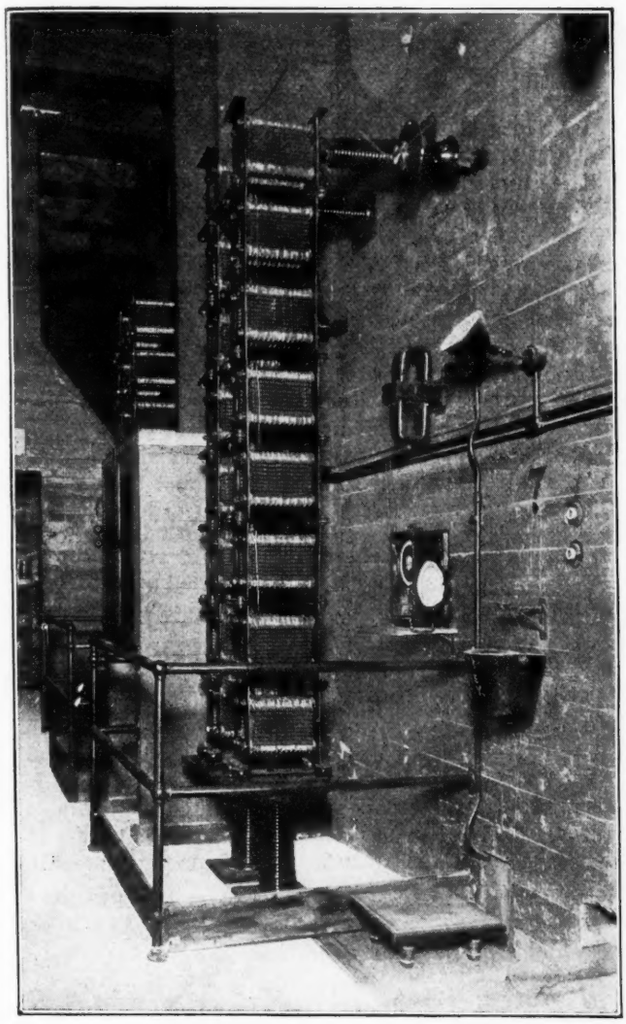


FIG. 2. NEUTRAL GROUND STACK CONNECTED IN STAR POINT OF HIGH-TENSION WINDINGS
Instrument to the right records ground current

Samples are tested in the testing transformer at Holtwood. The testing box (see Fig. 1) is cleaned, rinsed out with a small part of the oil sample, and the electrode terminals adjusted to 0.2 in. apart. The electrodes also are washed by oil taken from the sample. The box is now filled to within one-eighth inch of the top, and all air bubbles are broken with a glass rod. The voltage is applied and increased slowly and steadily at the rate of 50,000 volts in thirty seconds. The voltage at which the first spark across the gap occurs is recorded, also the voltage at the final breakdown. Three consecutive tests are made on each sample and the average recorded.

Good transformer oil should have a breakdown strength of 40,000 volts for a 0.2 in. gap. At Holtwood, oil that tests less than 30,000 is replaced at once. If retest shows breakdown between 25,000 and 30,000 volts, the oil is refiltered at the earliest convenience; if test shows less than 25,000 volts, the oil is filtered at once. When the oil tests between 30,000 and 40,000 volts, it is watched closely at the next monthly test to see whether the tendency is up or down. If on the next test it shows 40,000 volts, it is refiltered. The oil in use at Holtwood tests 50,000 to 60,000 volts. All filtered oil, new or old, is expected to test at least 40,000 volts immediately after filtering. If avoidable, oil is not tested damp days.

The transformer temperatures are not permitted to rise above 60 deg. C. (140 deg. F.) and in winter weather are not allowed to fall below 2 deg. C. above room temperature. Regulation of temperature is had by cutting in or out cooling coils. In the winter, changing over from forebay water to "hill" water keeps the transformers from becoming too cold. In severe cold weather it may be necessary to cut out all cooling coils and to excite idle transformers for a few hours every day. Caution is taken that the cooling-water main, which runs along the stop-log gallery, does not freeze when the transformer is idle and little water is passing.

Nos. 1 and 2 transformers, which are on the northern end of the power house and have external oil-filled cooling coils submerged in a water tank, have their temperature regulated best by adjusting the flow of water in the cooling tanks in the stop-log gallery. When shutting off from the cooling-tank water is not sufficient, the oil-pump motors are shut down, but care is taken to see that under no circumstances are the throttle valves on the oil lines closed, as such a condition would prevent natural circulation of the oil and likely cause local heating in the transformer.

All transformers which have their water or forced oil circulation shut off are carefully watched to detect sudden temperature rises. See screens, Fig. 3.

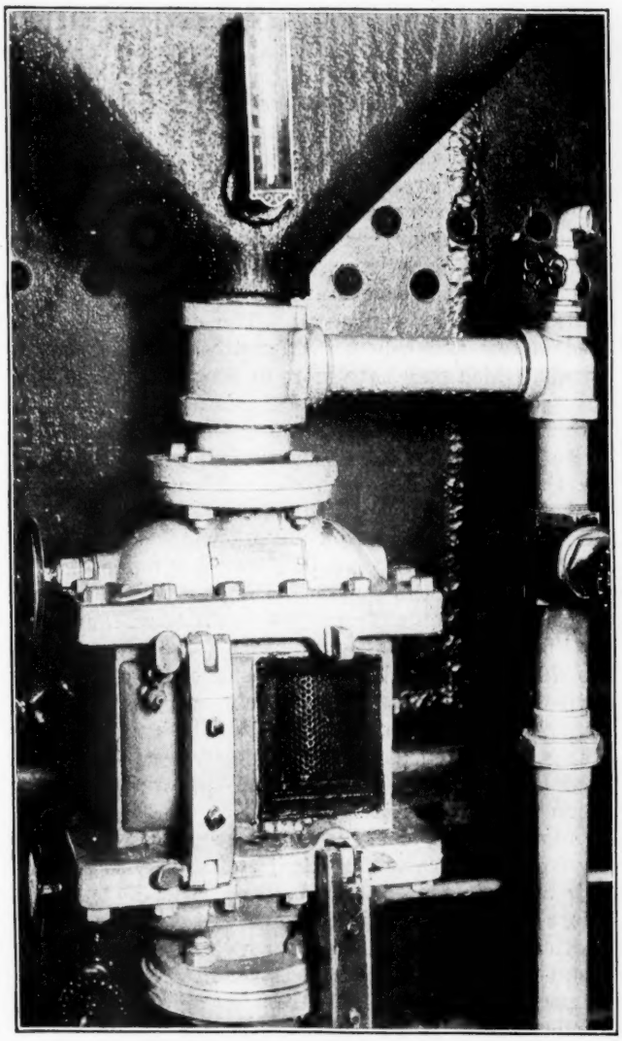


FIG. 3. CLOSE-UP VIEW OF THE TWIN STRAINER IN INCOMING WATER LINE OF THE TRANSFORMER
Pipe connections to the right are used for priming with high-pressure and for air connection when blowing out coils.

Functions of the Ammonia Condenser

By H. J. MACINTIRE

IN THE direct system of refrigeration there are three parts to the cycle—the compressor, the condenser and the so-called expansion coils. Of these three the condenser is the simplest and perhaps the least understood. The condenser is only a device to abstract heat from the ammonia (much simpler than the apparatus used for steam condensation) by the use of cooling water. The compressor superheat is first removed, then the latent heat of liquefaction, and then some heat is removed to reduce the temperature of the liquid ammonia. The object of the following is to bring forward the theory of the condenser in a simple manner, to show what the condenser must do, and finally to explain why inherently some designs of condensers must be inferior to others.

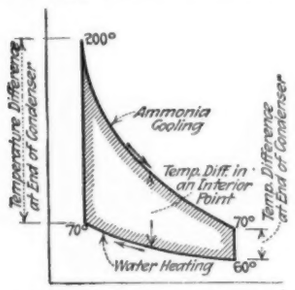


FIG. 1. DIAGRAM OF COOLING EFFECT WITH COUNTER-CURRENT CONDENSER

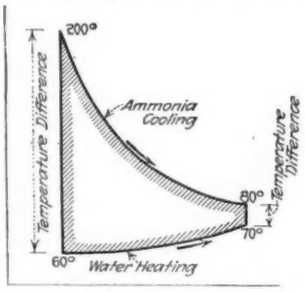


FIG. 2. COOLING EFFECT WITH OLD ATMOSPHERIC-TYPE CONDENSER

Now it must be remembered that the discharge gas from the compressor has a temperature between 140 and 240 deg. F. approximately, and that the heat in this gas above the temperature of about 80 deg. F. is called compressor superheat. The gas when superheated is dry and behaves differently from saturated ammonia, which may have more or less liquid ammonia always present in the form of a mist. The action of the condensers is first to remove the superheat and then to remove the latent heat of liquefaction; and while this heat is removed, the condensing water is heated five, ten or more degrees in temperature, depending on the relative amount of water being used for cooling. This action can be shown diagrammatically in Fig. 1, where the upper line shows the action of cooling the ammonia from 200 to 70 deg. and the lower line shows the action of heating the water from 60 to 70 deg. F. and the arrows show the relative direction of flow of the liquids, which is counter-current, or opposite in direction, in this case. The heat removed by the water is equal to the refrigerating duty performed plus the heat equivalent of the work of compression done by the compressor.

In another form of condenser the ammonia and the water flow in the same direction, as in the case of the old atmospheric type shown diagrammatically by Fig. 2. Here the coldest water comes in metal contact with the hottest ammonia and the condensed ammonia comes in metal contact with the hottest water. Now it must be remembered that in heat-transfer apparatus, such as condensers, it is necessary to have a temperature difference between the two substances and that heat will not run uphill, but only from the hotter to the colder substance. In consequence it will be noticed in Fig. 2 that the liquid ammonia is cooled only to 80 deg., whereas in Fig. 1 it was 70 deg., thereby giving in each case a final temperature difference of 10 deg. between the two surfaces of the condenser.

The object of the condenser is to remove heat from the compressed gas and to return the ammonia to a condition of a liquid that it may be fed again to the expansion coils. This means that: First, a cooling medium (water) must be provided; second, a temperature difference must be obtained; third, sufficient cooling surface must be available. Furthermore, the surfaces must be efficient and not insulated by foul gases or air or choked up by condensed liquid ammonia. In other words, a certain number of heat units must be removed by the cooling water every minute. In order to do so it must have a temperature difference (temperature head similar to a waterfall with water or potential in the case of electricity) and the proper amount of *efficient* cooling surface. The method of obtaining efficiency of the surface of the condenser is the reason for many and varied kinds of condensers.

In calculating condenser surface we use the external surface of the pipe, assuming that every square inch (top as well as bottom) is equally efficient. The metal is used only as a container for the ammonia. Heat is transmitted from the vapor or superheated ammonia to the metal, then through the metal to the water and is carried away by the water. Now suppose some air or inert gas collects on the inner walls of the condenser. This may easily occur, and does occur in every condenser. Then this foreign gas forms a film or skin on the metal and insulates the metal, Fig. 3. The reader will remember that air films make the most perfect insulator known. The effect of this is to decrease the rate at which heat will be transmitted through the condenser. By this is meant the number of heat units which can be conducted through the metal walls for every square foot with a temperature difference of one degree, during a time of one hour, as it is usually expressed. The value for this so-called coefficient of heat transmission may be 200, but if a gas film is

FIGS. 3 TO 6. ILLUSTRATING COOLING ACTION IN AMMONIA CONDENSERS

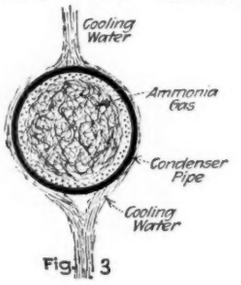


Fig. 3

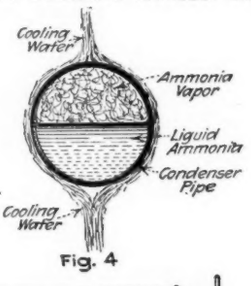


Fig. 4

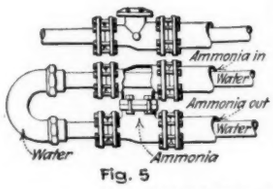


Fig. 5

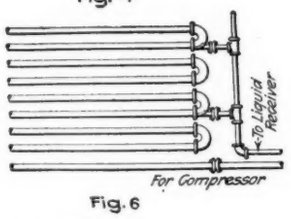


Fig. 6

Figs. 3 and 4—Liquid, gas and water in and on condenser coils. Fig. 5—The double-pipe condenser. Fig. 6—The bleeder-type condenser.

present on the pipe surface it may be reduced to 50 or less.

As was mentioned, the vapor film is always present on both sides of the pipe. Its baneful action may be diminished by scouring it away by making the substances on the two sides of the pipe move vigorously. A vigorous current of ammonia vapor along the pipe has the same action as water running down a mountain brook—it scours the sides and removes this gas film. Therefore it is evident that if the condenser is operated so as to increase the velocity of the vapor in the condenser, the efficiency of the condenser will increase and more work can be obtained from it. However, to get this velocity of the vapor work must be done on the vapor by the compressor so that the advantage is not all clear gain.

Again, some designs of condensers allow the pipes to fill part way with liquid ammonia. This is particularly true of the old atmospheric and the so-called flooded condenser. Referring to Fig. 4, it will be seen that the lower half is filled with liquid ammonia. That the accumulation of a liquid, as in this case, practically nullifies the action of that part of the condenser can be seen by anyone who has studied the action of the

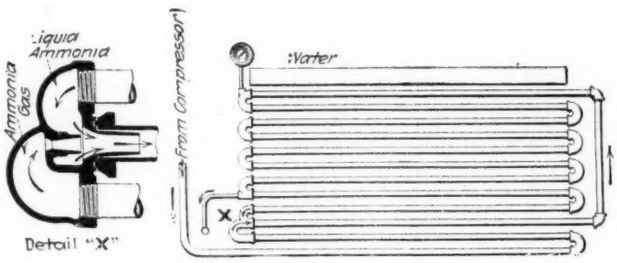


FIG. 7. SHOWING THE FLOODED CONDENSER

steam boiler. In this case the useful part of the condenser is reduced in proportion to the amount of submerged surface. Of course some heat is transmitted through the liquid, but the action is very sluggish as compared with the other portion of the pipe.

What then are the requirements of a condenser to get best heat transfer? It must be free from air or foreign gases and it should have a velocity flow of the vapor which will tend to clean the metal surface. It must be free of oil or scale on both the inside and outside surfaces. It must be arranged so that the liquid when precipitated will be readily and quickly drained off. And finally, as economy of the refrigerating plant—as regards both head pressure and refrigerating effect of the condensed ammonia—is dependent on having as low a temperature of the liquid ammonia as is possible, the condenser should be designed on the counter-current principle.

Now, what condensers are best suited for all these requirements? If good condensing water were available, the double-pipe condenser (counter-current) would answer every requirement. Foreign gases are removed by purging. The scouring action is obtained by the construction (Fig. 5). The only objection is that the lower pipes are likely to be partly filled with liquid ammonia, but this is partly compensated by the fact that the liquid is cooled as near the temperature of the incoming condensing water as is practical. The design, however, is costly, there are a number of joints to keep tight, and water tending to accumulate sediment cannot be used.

One of the oldest designs, and one that answers the requirements of an efficient condenser, is the so-called bleeder type of atmospheric condenser. This is counter-current (Fig. 6), the superheated gas entering at the bottom, and as it works its way upward and is condensed, it is drained off to the receiver. If properly constructed, there should be little or no accumulation of liquid, and the design is such as to be very inexpensive to make. The flow is toward the upper header, where the inert gases are readily purged. As the cooling water is always on the outside, the scale or sediment may be cleaned readily. The only real objection is that the liquid ammonia is not precooled, but is drained off as it is condensed.

Finally (Fig. 7), as regards the flooded condenser: The real object of such a condenser (which attempts to use condensed liquid ammonia to remove the compressed superheat by a kind of jet condenser action) is to try to overcome the poor heat transference from dry, superheated ammonia to the cooling water. If the ejector effect is automatically controlled to suit the load, the condenser will operate all right, although the condition shown in Fig. 4 will always be present. Experience has shown that when adjusted to the conditions then prevailing, the flooded condenser will work very well, but that any change may make the head pressure increase greatly. Tests have been published attempting to show that no advantage was derived by the flooded condenser, and of two evils most engineers prefer a low operating cost to a low first cost. The writer's personal opinion is that there is no advantage in the flooded condenser which the bleeder type cannot equal, also that the latter is the best all-around condenser made at the present time.

Large Single-Shaft Turbine in Berlin

BY DR. F. E. JUNGE

The General Electric Co., of Berlin, has just completed a turbo-generator set of 50,000 kw., or 67,000 hp. in a single unit. This, the largest machine of its kind in Europe, and like some other large installations is a single shaft unit generating its current in one generator.

The generator rotor weighs 106 tons; the weight of the complete generator is 225 tons. The turbine rotor weighs 49 tons and the complete steam turbine, 250 tons. To transport the various parts of the unit to the place of destination quite a number of special cars had to be constructed, among them one with five axles for the rotor part of the generator.

The power plant comprises two condensers, each having a cooling surface of 3000 sq.m. (32,292 sq.ft.) which is subdivided into four parts so as to facilitate transportation. The weight of the condensing plant is 100 tons. The steam turbine contains 10 blade wheels, the diameters of which vary from 3.4 to 3.8 meters (11.15 to 11.46 ft.), the circumferential speed of the wheels varying accordingly between 180 and 220 m. per sec. (590.4 and 72-16 ft. per sec.).

Owing to the absence of nickel and other high-class materials, guides and blades had to be specially designed, being cut from solid blocks of metal, of the material of which the finished blade represents only 15 per cent. The generator rotor has an external diameter of 2.2 m. (7.22 ft.) and a circumferential speed of 115 m. (377.2 ft.) per sec. Its total length including shaft

stubs being considerable, it had to be composed of a series of disks, mounted and compressed on a common shaft.

The generator rotor was tested at a speed 50 per cent. beyond the normal; namely, at 1500 r.p.m. The single sectors or disks were subjected to even more severe tests at 2000 and 2400 r.p.m. The three main bearings of the set have a diameter of 0.6 m. (1.968 ft.) a circumferential speed of 32 m. (105 ft.) per sec. Owing to the colossal load which it supports, the middle bearing is divided into two parts. The rigid coupling between turbine and generator rotor is contained between.

This central bearing is rigidly connected with and supported by the main frame, while the turbine housing and its steam connections rest on the middle and front bearings respectively and can glide along the main axis, thus yielding to the expansion and contraction produced by varying temperatures. The main frame rests on a broad foundation of concrete steel.

The Coking-Coal Chain Grate

A successful coking chain-grate stoker suitable for burning and caking coal must be provided with some sort of an oscillating coking plate to break up the fuel bed during the early stages of combustion, in addition to the usual chain-grate surface. Such a stoker is manufactured by the Green Engineering Co., East Chicago, Ind. From the general view, Fig. 1, it will be seen that the stoker is provided with a horizontal deadplate over which coal is pushed into the furnace,

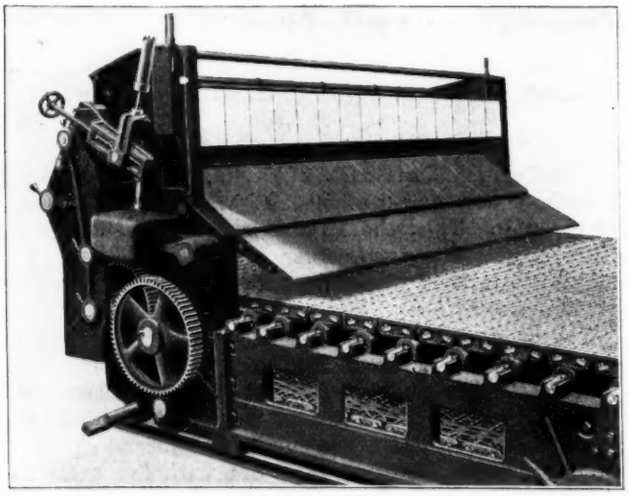


FIG. 1. CHAIN GRATE STOKER FOR COKING COALS

an inclined adjustable deadplate directly below this and an oscillating plate below the adjustable coking dead-plate.

Fuel is pushed from the stoker hopper under the gate by means of a pusher resting on the horizontal dead-plate. The pusher receives its motion from an eccentric through a walking-beam and rocker-arm mechanism. A through shaft communicates this motion uniformly to both sides of the stoker, thus actuating the pusher from both ends. The design of the pusher provides flexibility in firing as the end adjustments allow quick increases in the rate of firing and permit feeding more or less coal on either side of the grate as desired. The pusher is divided into sections 12 in. wide, each of which is provided with a variable stroke mechanism so that the amount of fuel fed to any section of the grate is under control independent of the rest of the grate surface. This makes it possible to regulate the feed so as to prevent uneven fuel-bed conditions.

As the coal is pushed over the horizontal dead-plate, it passes onto an inclined adjustable dead-plate the width of the stoker and 14 in. deep. This plate is made up of a series of sections 18 and 24 in. wide, mounted on a square shaft in such a manner that the slope can be adjusted to suit coals of varying coking tendencies, but no operating motion is given.

From the adjustable dead-plate the semi-coked fuel passes to the coking plate forming the lower stage

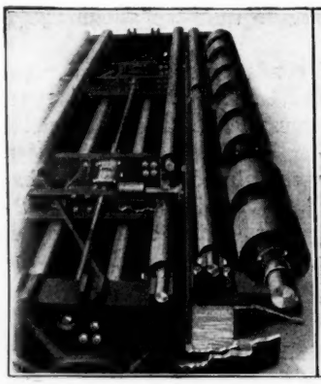


FIG. 2. WATER-COOLED REAR GIRDER

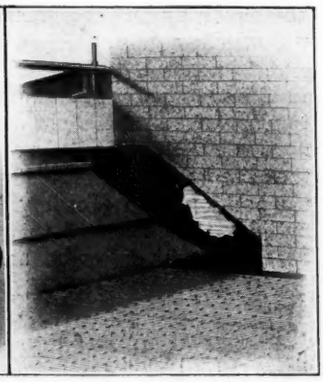


FIG. 3. WATER-COOLED LEDGE PLATE

of the incline before reaching the chain surface. The coking plate is the width of the furnace and 18 in. deep. It is divided into sections 18 and 24 in. wide, mounted on a square shaft, to which an oscillating motion is given by means of an eccentric and walking beam. The lower edge of the coking plate moves through an arc of variable degree as to amplitude and location, governed by the position of an adjusting screw.

The motion of the fuel pusher and coking plate is independent of that of the stoker chain so that it is possible to feed fuel beds of any practical depth onto either a slow or fast moving chain and to provide any desired amount of agitation to the coking plate necessary to maintain a porous fragmentary fuel bed at the chain surface.

One important function of the incline is that the fuel bed is tipped at an angle to expose the green fuel to direct radiation from the rear portion of the fuel bed. On this account fuel is ignited at a rate beyond the possibilities of igniting arches on plain chain grates, so that the stoker is responsive to sudden increases in steam demand.

A semi-steel box of large section arranged for water circulation is shown in Fig. 2. Provision is also made to keep the incandescent fuel from coming in contact with the brickwork in the setting walls adjacent to the to the coking plates, as in a heavily agitated fuel bed accretions are formed during the distillation of the tars. The water-cooled ledge plates shown in Fig. 3 serve to prevent clinker adhesion and erosion of the brickwork.

Work has begun on the $2,500,000 hydro-electric power plant of the San Joaquin Light and Power Co., on the San Joaquin River. The plant when completed will develop 28,000 hp. The tunnel feeding the water turbines will be about two miles long.

Riley Two-Speed Gear Box

The tendency in stoker operation is toward greater flexibility of operation so that the feed of the coal may be retarded or accelerated as desired and the fire can be leveled, thinned or thickened as required. These results are obtained in the instance of the Riley stoker by means of the new two-speed gear box. It differs from the regular design of stoker gear box in that it contains in addition to the worm gearing, a double set of spur gears so arranged that by shifting a lever from the high to the low position or vice versa the coal feed is increased or decreased.

When a number of stokers or gear boxes are driven by a single prime mover, any stoker or the retorts on any gear box can be operated practically independently of all other stokers or gear boxes. This effects a saving in fuel since there is no necessity for carrying over coke when trying to divide the load equally among a

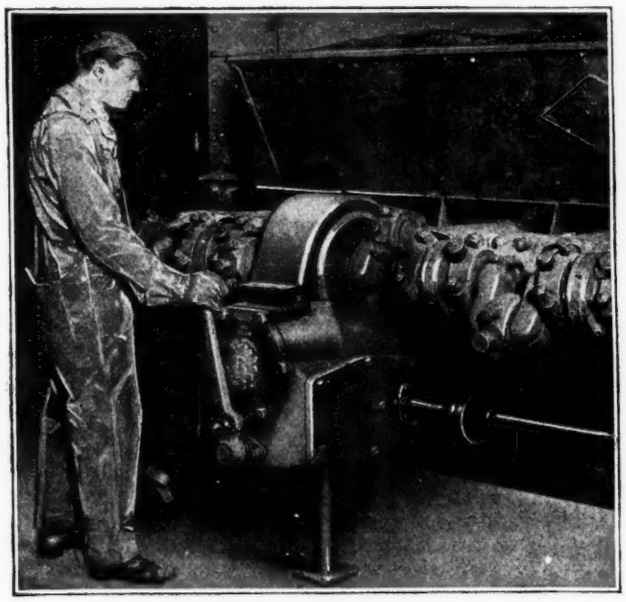


FIG. 1. TWO-SPEED GEAR BOX APPLIED TO A 14-RETORT STOKER

number of stokers, or when building up thin sections of the fuel bed in a wide furnace.

With the stokers driven by an ordinary engine or motor, double the usual range of speed is obtained. This is an advantage at high ratings (300 to 350 per cent.). The stoker countershaft at these loads usually has a speed of from 400 to 450 r.p.m. Suppose, for example, the load is suddenly reduced to about the rating on the boilers. An engine, to handle this, would need to operate from 100 to 150 r.p.m. Such low speeds are not only likely to stall the engine, but are extremely wasteful of steam by shifting the two-speed gear-box lever from high to low speed, the engine can run at from 200 to 300 r.p.m. an efficient speed for economical operation.

The installation of the two-speed gear box, manufactured by the Sanford Riley Stoker Co., Worcester, Mass., makes the slip-ring induction motor more suitable for stoker drive. A 2 to 1 reduction in speed is all that can be obtained electrically, but with this new device an over-all range of speed of 4 to 1 is obtained. A multi-speed motor with four speeds (600, 900, 1200, and 1800 r.p.m.) can now give the equivalent of 300, 450, 600, 900, 1200, and 1800 r.p.m. If the motor operates at a maximum of 1800 r.p.m. during peaks, then a sudden change in steam requirements does not necessitate feeding an excess amount of coal to the boiler. A single throw of the shifter lever from left to right, cuts the coal supply in half. This is done without a change in the speed of the motor.

Figs. 1, 2 and 3 show the simplicity of an installation. Fig. 3 shows how all gear boxes are driven from one

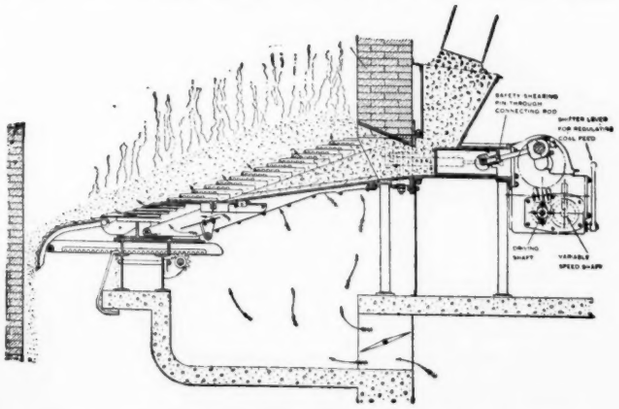


FIG. 2. SIDE ELEVATION OF GEAR BOX, SHOWING ARRANGEMENT OF GEARS

through shaft. It is therefore obvious that all sprockets and chain connections, chain guards, countershafts, and bearings usually required for each gear box are eliminated, and each stoker so equipped has but one chain connection. With large units this saves a great deal of mechanism underneath the stoker. By using the two-speed gear box the stokers could be set much lower; in fact, the bottom of the box can be set on the floor, which enables the stoker to be set low and gives maximum combustion space for the gases.

The use of this additional regulating feature does not interfere with the continued use of any automatic

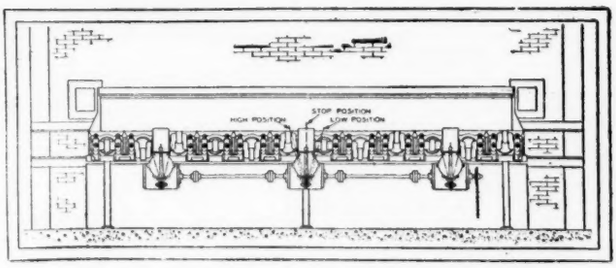


FIG. 3. SHOWING CONTINUOUS SHAFT LINE

regulating device; in fact, it allows a more intelligent use of any automatic regulator on the stoker drive, and it is so constructed that it may be applied to any type of Riley stoker.

The old adage has it that "time is money," and yet some of the poorest people we know have all the time there is on their hands. Time is money only when we turn it into money; that is, when we make ourselves so efficient, so capable or of such service to others that our days and hours can readily be exchanged for cash. Time is money only when we can, by the strong transforming power of real ability, produce something, somewhere, which is in demand by somebody.

The frames of all motors, switchboxes, transformers, etc., should be substantially grounded.

Some Facts About Monel Metal

By HUGH R. WILLIAMS*

CONDITIONS surrounding the use of high-pressure steam, particularly when superheated, are different from those met with in low- or medium-pressure saturated steam practice. High-pressure strains, greatly elevated temperatures and intensified erosive action, all have to be contended with, making necessary the employment of much equipment of a character different from that suitable for less severe conditions. Particularly is this so of the metals employed.

The requisites for a metal to withstand the high pressures, the total heat—possibly as high as 800 deg. F., or even higher—and the erosive action of high-pressure superheated steam are: (1) High tensile strength at all temperatures; (2) low heat conductivity; (3) high modulus of elasticity; (4) a coefficient of expansion permitting its use in combination with other essential metals; (5) capacity to resist the erosive action of the steam. If, in addition, the metal might be of a noncorroding nature, markedly resisting oxidation, it would be the ideal metal for superheated steam service.

Valve manufacturers, upon whom devolved the important necessity of producing devices to control and regulate the flow of the more powerful operating medium, were among the first to appreciate the inadequency of their former product to handle successfully high-pressure superheated steam. Cast-steel valves were necessary to replace the extra-heavy cast-iron ones suitable for steam pressures up to 250 lb. to withstand the increased steam pressures and the much more marked elevations in temperature without unduly adding to the weight of the valves. These valves, as in the case of iron-body valves, required seat rings, valve disks and other fittings and trim made of durable and noncorroding metal to assure tight closure in operation.

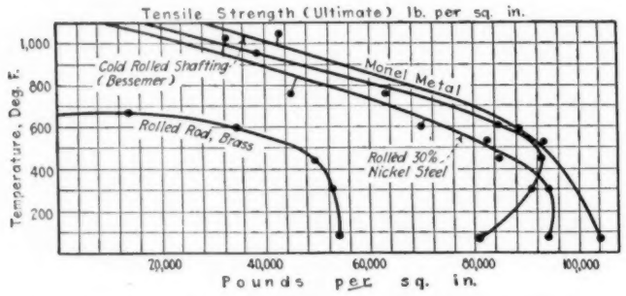


FIG. 1. BEHAVIOR OF MONEL AND NICKEL STEEL

The fittings for iron valves, usually of brass or bronze composition, are not suitable for cast-steel valve service, for the coefficient of expansion of cast steel is nearly double that of cast iron, brass or the bronzes used for valve fittings. The difference in the expansion of the valve-body metal and the valve fittings under the range of temperature encountered in high-pressure superheated-steam service would be such as to prohibit tight closure and produce serious deformation of valve seats, etc., at unusual temperatures. The difficulty was overcome by making the fittings for cast-steel valves out of monel metal, a natural alloy of individual characteristics, possessing a coefficient of expansion practically identical to that of steel. This monel metal is noncorrodible, strong as steel, tough and ductile. It takes and retains a high finish, is a better resistant to acid and alkaline corrosion than any of the common metals and is practically impervious to oxidation. It can be machined, forged, soldered and welded, both electrically and by the oxyacetylene process.

This metal is a natural product of the distinctive nickel and copper ores mined in the Sudbury district, Ontario, Canada. The ore is a basic igneous rock carrying sulphides of nickel and copper with pyrrhotite

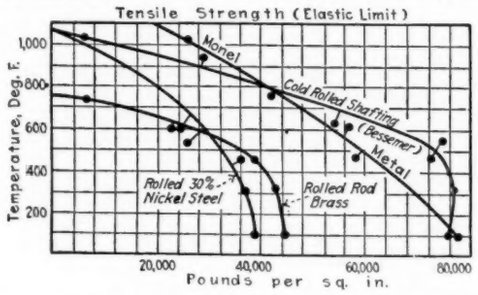


FIG. 2. ELASTIC LIMIT AT HIGH TEMPERATURES

(magnetic pyrites) as constituents—the sulphides more or less segregated—and is smelted to matte form by a special roasting process that drives off the sulphur content without disturbing the balance of the main metal ingredients, copper and nickel. The process practically eliminates the sulphur content, and the matte, refined to get rid of impurities, produces a metal of unusual uniformity of composition—nickel, 67 per cent.; copper, 28 per cent.; and other elements, chiefly iron from the original ore and manganese, silicon and carbon introduced during the process of refining, 5 per cent.

The physical characteristics of the metal—it was not until 1906 that a practical method of producing monel metal was developed—are decidedly distinctive and individual. They are not and cannot, so far as known, be possessed in any like measure by synthetic mixtures of similar ingredients, for no mechanical process, so far as known, can produce the intimate combination resulting from centuries of geological formature.

The requisites for a metal to withstand the severe conditions of high-pressure superheated-steam service are apparently all possessed by monel metal, as evidenced by its physical properties. The one question remaining in doubt, or not conclusively established by the physical properties of the metal under normal conditions, is its ability to withstand effectively the universally weakening effect of high temperatures.

However, a series of comprehensive and exhaustive tests conducted by some of the leading valve manufacturers showed that in this respect monel metal is quite unique among metals in having its strength less influenced by elevated temperatures than any other known metal. Under any heat up to 1000 deg. F., its ultimate tensile strength in rolled form is considerably greater than that of any other metal ordinarily furnished in the form of rods. It is considerably stronger than

*The International Nickel Co.

30 per cent. nickel steel at all temperatures and at high, as well as normal, temperatures is stronger than cold-rolled shafting bessemer. Even at 500 deg. F., at about which temperature cold-rolled shafting possesses its maximum strength, monel-metal rods are slightly the stronger. At the elastic limits of the various metal rods, monel metal possesses greater tensile strength than do rods of any other metal at temperatures exceeding that of about 800 deg. F. Below this temperature, bessemer cold-rolled shafting is somewhat the stronger at the elastic limits of the respective metals, but monel metal resists the action of corrosion and oxidation far more effectively.

Under torsion monel-metal rods are even stronger than bars of vanadium tool steel at temperatures in excess of 600 deg. F. and at all temperatures monel-metal rods are stronger than rods of nickel steel, any of the bronzes, cold-rolled shafting, machinery steel, delta metal, etc.

In the form of rods the metal is also of quite unusual importance in the power house. Monel-metal pump and piston rods, in particular, are highly economical, for they are more durable than steel or bronze rods and effect a substantial saving in power consumption and the use of packing. They do not score or pit and acquire a smooth, glassy surface in service that reduces friction to a minimum, avoids wear on the packing and eliminates to a great extent the leakage evil.

For parts of valves, in fabricated forms as bolts, nuts, screws, etc., for severe service and for use in connection with cast-steel mechanisms, monel-metal rods find many uses.

Another use of monel-metal rods, in which service the metal has also assisted in power-plant practice, is in connection with steam-turbine construction. The successful development of the steam turbine has been dependent to a considerable extent upon employing a suitable metal for the blades. A metal is required that will stand up well under the erosive action of high-pressure steam, resist corrosion, will retain strength at elevated temperatures and which can be worked easily into the required shapes. The first three requirements are essential and the last a matter of practical consideration.

There are three classes of metals—brasses, nickel steel and monel metal—that meet each of the four requirements to a certain extent and on that account have been quite extensively employed for steam-turbine blading. Brass can be worked into any required shape with little difficulty, it is noncorrodible and resists the erosive action of steam fairly well, but it lacks strength for use in large units and under a considerable temperature range loses much of its strength at normal temperatures. For instance, in superheated-steam service under high pressure it may lose as much as 40 per cent., or even more, of its strength at 70 deg. F.

Nickel steel does not possess the quality to resist corrosion or to withstand high-pressure steam erosion so desirable, if not absolutely essential, in a steam turbine. Its strength at ordinary temperatures is ample, but at a temperature in the neighborhood of 800 deg. F. it loses from 50 to 60 per cent. of its normal strength.

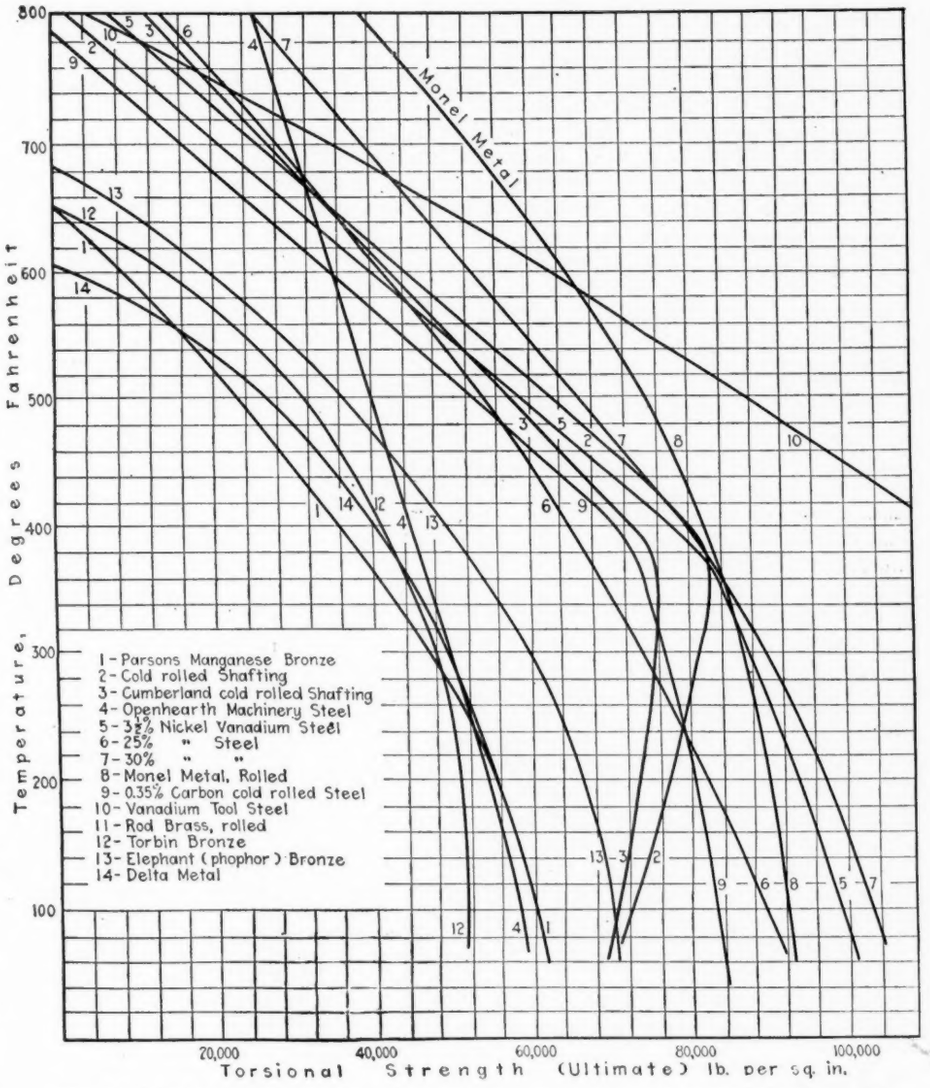


FIG. 3. BEHAVIOR OF MONEL AND OTHER METALS AT HIGH TEMPERATURES

Monel metal can be worked easily into all necessary forms for turbine blading, resists corrosion and the erosion of high-pressure steam even better than does brass, on account of its high nickel content, is very nearly as strong as nickel steel at ordinary temperatures and resists the weakening influence of elevated temperatures far more effectively. At 800 deg. F., monel metal retains as much as 66⅔ per cent. of its strength at ordinary temperatures and is some 30, or more, per cent. stronger than nickel steel at the same temperature.

[We believe that readers may get the impression from

the foregoing, that monel metal is more widely used for turbine blades than it actually is. It does make an excellent material for such service; but most builders, because of the expense, do not use it for turbines to the extent that might be inferred from the article. Nearly all builders agree that there is slight difference between the wearing qualities of a good nickel steel and monel metal. However, from a shop viewpoint, the chief disadvantage of the latter is that it is severe on dies and increases die charges. One of the largest builders of steam turbines in this country has never used monel for the blades except for one small single-wheel impulse machine in which the steam velocities are exceedingly high. This builder doubts that monel is as good for high-speed blades as pure nickel, which is now available. Great physical strength in the high-pressure blading in modern turbines is not vital. For the sake of efficiency all such blading, whether impulse or reaction, should operate at slow speeds, which result in low mechanical stresses. For the exhaust end blading where these stresses are high low-carbon, nickel, electric-furnace steel is widely used.—Editor.]

TABLE OF PHYSICAL PROPERTIES

Melting point of monel metal, deg.	1,360 C. (2,480 F.)
Specific gravity (cast)	8.87
Weight per cu.in. (cast), lb.	0.319
Weight per cu.in. (rolled), lb.	0.323
Coefficient of expansion (20 deg. C.—100 deg. C.)	0.00001375 per deg. C.
Electrical resistivity, 256 ohms per mil-foot (temp. coefficient), 0.0011 per deg. F.	
Electrical conductivity	4 per cent. (copper 100 per cent.)
Heat conductivity	1/15 that of copper
Shrinkage	¼ in. per foot
Hardness, cast material	20–23 (Shore scleroscope)
Hardness, hot rolled rods	27 (average shore scleroscope)
Hardness, hot-rolled rods	162 (average Brinell)
Modulus of elasticity	22,000,000–23,000,000

TESTS ON RODS

Tensile

Average respresentative tests of each of the three divisions as given:

	Yield Point, Lb. per Sq. In.	Ultimate Tensile Strength, Lb. per Sq. In.	Per Cent. Elongation in 2 In.
Up to 1 in.	63,126	94,562	40
1⅛ in. to and including 1⅜ in.	61,963	93,104	39
1½ in. to and including 2⅛ in.	50,115	87,678	42
2½ in. to and including 3½ in.	43,805	85,282	44
Over 3½ in.	47,335	84,763	43
Rectangles	56,353	85,562	42
Hexagons	60,736	87,781	40

Torsional (Average)

Shearing stress—lb. per sq.in. on remotest fibres:	
At elastic limit	31,796
At ultimate load	79,053

Compression

Elastic limit ..... 25,500 to 32,000 lb. per sq.in.

TESTS ON CASTINGS

Tensile

Average of 172 heats tested for Isthmian Canal Commission:

Yield point	37,093 lb. per sq.in.
Tensile strength	72,281 lb. per sq.in.
Elongation in 2 in., per cent	34
Reduction of area, per cent	32

Compression

Elastic limit ..... 12,000 to 25,500 lb. per sq.in.

Wattmeter Wrongly Applied

BY E. C. PARHAM

In measuring the power taken by a three-phase motor from a three-phase circuit, it is customary to use two wattmeters, connected as shown in Fig. 1. With this connection, if the power factor is higher than 0.50, the total power absorbed will be the sum of the meter readings. Where only one wattmeter is available, the current coil is connected in series with one of the phase wires and one end of the potential coil is permanently connected to that phase wire, the other end being left free to be applied alternately to the other two-phase wires, as in Fig. 2. The sum of the two readings obtained gives the power absorbed. Where two meters are used, their readings will not be equal unless the load is strictly noninductive and balanced, because only then are the phase relations of the currents and voltages, acting on the meters, the same. It is therefore usually not correct to assume that the total power of the circuit is measured by twice the reading of an instrument that is actuated by the voltage and current of a single phase. In the case of two instruments that do not give equal readings, twice the reading of one would give a result too large and twice the reading of the other would give a result too small. It follows, then, that even when the load is evenly balanced on the three phases of a three-phase motor, the indication of a single wattmeter that is permanently connected to one of the phases cannot

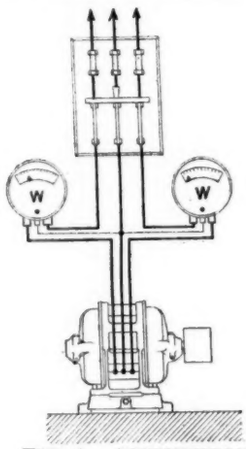


FIG. 1. CONNECTIONS WITH TWO WATTMETERS

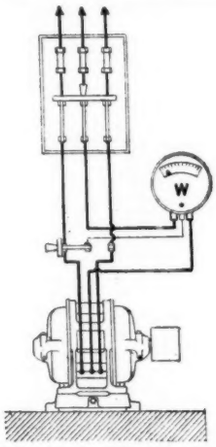


FIG. 2. CONNECTIONS WITH ONE WATTMETER

be taken as a measure of the total power supplied to the motor.

A certain three-phase induction motor was reported to be heating to a greater degree than its connected load would appear to warrant. It was stated that the trouble probably was in the motor because a wattmeter had been applied and it had indicated the motor to be operating at far below rated full load. By using two wattmeters an inspector determined that the motor was about 20 per cent. overloaded; also he found that it had absolutely no air circulation due to its ventilating ducts being stopped up with lint. Notwithstanding these conditions, the motor was not heating dangerously. In order to relieve the conditions the ventilating ducts were cleared and the operator built a tin chute by means of which air was directed onto the motor.

The reason why the operator's wattmeter measurement had indicated the motor to be very much underloaded was that he had connected the meter permanently to one phase and that happened to be the phase to which the lower-reading meter was connected when the inspector applied two meters. The multiplying of this reading by two would have given a result less than the full-load rating of the motor, but the operator's error was further increased by using 1.73 instead of 2 as a multiplier.

Only 125 American vessels were lost during the war, as compared with 3147 British—or 385,967 tons, as against 7,818,870 tons under the British ensign. Greece lost 162 vessels and Norway 781, both these neutrals suffering much more severely than the United States.

The Electrical Study Course—Introduction to Alternating Current

Discusses how the flow of an electric current through a circuit depends on the maintenance of a voltage across the circuit and gives hydraulic analogies of alternating and direct currents.

ELECTRIC currents as used for power and lighting are divided into two general classes, direct and alternating. The Electrical Study Course Lessons have, up to this time, been devoted almost exclusively

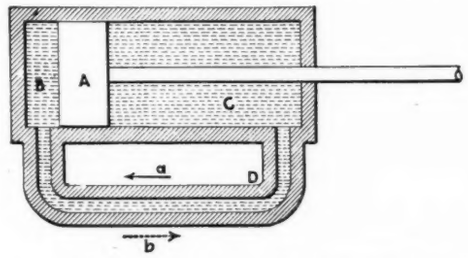


FIG. 1. HYDRAULIC ANALOGY OF ALTERNATING CURRENT

to a consideration of the former class; treatment of the latter is inaugurated in this lesson.

It was shown in the case of direct currents that a flow of current depended on the maintenance of a voltage; that is, it is necessary to have a difference in voltage between two points before current can flow from one to the other. Thus, in a generator, a voltage is caused to exist across the terminals of the machine by rotating the armature in the magnetic flux of the field. Whether current flows, and if so, how much, depends upon providing a path for the current, such as a resistance, or lamps, or motors, connected between the terminals, and the magnitude of the current is controlled by the load so connected. If no load is connected no current will flow, although the voltage exists across the terminals just the same. It is therefore apparent that a voltage may exist without a flow of current, but an electric current cannot exist unless there is a voltage present to cause the flow. These conditions are similar to those found in a hydraulic system. We may have a pump furnishing water at a certain pressure. If the outlet valve is closed, the flow of water will cease but there will still be pressure at the pump. On the other hand, if the pressure is zero, there can be no flow of water even though the valves be wide open.

It is of great importance to establish firmly in one's mind the foregoing fact; namely, that flow of current is dependent upon the presence of voltage. It holds true for alternating currents as for direct; that is, in order to have an alternating current we must first have a source of alternating voltage. It will therefore be logical to treat of alternating voltages before concerning ourselves with the currents caused to flow by them.

The usual method of producing an alternating voltage is to employ a generator as in the case of a direct voltage. Such generators are often called alternators. There are various forms of them. The smaller sizes are often of a design identical with that of the direct-current type with the exception that the armature winding is connected to slip rings instead of a commutator. In fact, any direct-current generator could be used as an alternating-current machine if slip rings were provided and connected to the armature winding in the proper manner. In this regard we can refer back to the discussion on the direct-current generator, in which, it will be remembered, it was found that it is really an alternating voltage that is generated and that the purpose of using a commutator is to rectify this alternating voltage into a direct one. In addition to this type, which is familiar to us from our direct-current studies, there is a type of alternator—and it is the one used almost exclusively for machines of any considerable size—in which the armature is stationary and the field revolves. This type will be treated of subsequently. For the purpose of studying alternating voltages we shall confine ourselves to the type of machine with which we are familiar; namely, that in which the field is stationary and the armature revolves.

Before actually taking up the development of an alternating voltage in such a machine, it will be necessary to investigate what is meant by the word "alternating" when applied to an electric voltage or current. For this purpose let us go back to a consideration of the hydraulic analogy. Suppose that we have a plunger pump with its cylinder ends connected through a system of piping, as shown in Fig. 1, and that the cylinders and pipe are completely filled with water. Then, when the piston *A* is pulled to the right, water will flow from *C* to *B* through the pipe *D* in the direction of the solid arrow *a*. When piston *A* reaches the end of its stroke, the flow of water will cease momentarily, and then, as

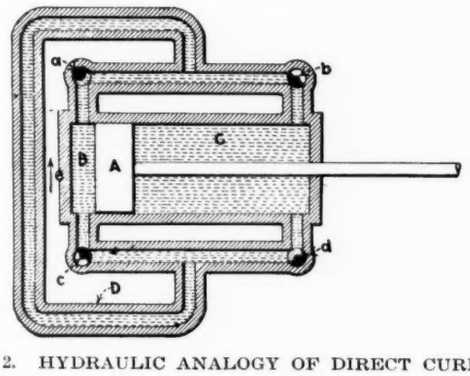


FIG. 2. HYDRAULIC ANALOGY OF DIRECT CURRENT

the piston begins to move in the opposite direction—that is, to the left—water will flow from *B* to *C* in the direction of the dotted arrow *b*. As *A* approaches its limit of travel to the left, the flow of water will again stop, to be resumed in the same direction as at first when the piston once more begins to travel to the right. It is apparent that for each stroke of the piston the direction of flow in the pipe *D* is regularly reversed. Such a flow would be called alternating.

If the arrangement were that shown in Fig. 2, the flow in the pipe would always be in the same direction if the valves *a*, *b*, *c* and *d* operated correctly. In the figure the piston *A* is ready to move to the right and the valves *a* and *d* are open to allow the water in *C* to be forced into *B*, causing it to flow in the direction of the

arrow *e* through the pipe *D*. The other valves, *b* and *c*, are closed and remain so until the piston *A* has reached the end of its stroke, whereupon they are opened and *a* and *d* closed. On its return stroke *A* would then force water from *B* into *C* through the valve *c*, pipe *D* and valve *d*, in the same direction through *D* as before. Thus the flow in the pipes is always in the same direction and may therefore be called a direct flow. Hence, the valves may be looked upon as serving the purpose of a commutator for rectifying the alternating current of Fig. 1 into the direct one of Fig. 2.

The steadiness of flow in Fig. 2 depends on the action of the cylinder and the time required for the reversal of travel, and it will therefore be more or less pulsating in character, but nevertheless always in one direction. A like condition obtains in the case of Fig. 1; that is, the character of flow and its reversal depend upon the characteristics of the steam pump. This idea can be carried still further and can be applied to electrical pressures or voltages, instead of to water or steam pressures, as will be shown in the following lesson.

In the problem of the preceding lesson it was required to construct the efficiency curve of a motor, having given the results of a brake test as contained in the table herewith, and that the effective pulley diameter is 8¼ in.

Reading No.	*E* Volts	*I* Amperes	*S* R.P.M.	W_1 Lb. Oz.	W_2 Lb. Oz.
1	110	12.5	1200	24-06	10-05
2	110	25.0	1150	58-15	19-12
3	110	37.5	1100	92-11	27-07
4	110	50.0	1050	131-12	35-03
5	110	62.5	1000	170-05	43-10

We first find the outputs for the various readings from the formula, $hp. = \frac{\pi \times D \times S \times (W_1 - W_2)}{33{,}000 \times 12}$, in which *hp.* represents the output in horsepower, $\pi = 3.142$, *D* represents the effective pulley diameter in inches, *S* the speed in r.p.m., W_1 the indication of the beam scale in pounds, W_2 that of the spring balance in pounds, and in which 33,000 is the number of foot-pounds per minute in one horsepower, and 12 is a factor for reducing *D* from inches into feet. Since all the quantities except *S*, W_1 and W_2 are constant, we may write

$$hp. = \frac{\pi \times D \times S \times (W_1 - W_2)}{33{,}000 \times 12} = \frac{3.142 \times 8.25 \times S \times (W_1 - W_2)}{33{,}000 \times 12}$$

$= 0.00006546 \times S \times (W_1 - W_2)$. Then, substituting the values of the various readings will give us the value of *hp.* corresponding to each. Thus, for reading No. 1 we have $hp. = 0.00006546 \times 1200 \times (24\text{-}06 - 10\text{-}05) = 1.105$. Making a similar computation for each of the other readings gives the results contained in the third column of the table herewith:

Reading No.	Input Hp.	Output, Hp.	Efficiency Per Cent.
1	1.843	1.105	59.96
2	3.686	2.950	80.03
3	5.529	4.699	84.99
4	7.373	6.638	90.03
5	9.216	8.294	90.00

The horsepower inputs are obtained by multiplying the volts by the amperes for each reading and dividing by 746. That is, *horsepower input* $= \frac{EI}{746}$. Applying this to reading No. 1, we have, *horsepower input* $= \frac{110 \times 12.5}{746} = 1.843$ *hp.*, and by making a like substitution for the remainder of the readings we obtain the results entered in the second column of the table of results. To determine the efficiencies, as given in the last column, the values in column 3 are divided by the corresponding ones of column 2, and the result multiplied by 100 to convert it into percentage. Then the efficiency curve is constructed from the values in the third and last column as shown in Fig. 3.

A 50-hp. motor whose rated speed is 1000 r.p.m. is to be tested for efficiency up to 25 per cent. overload, by

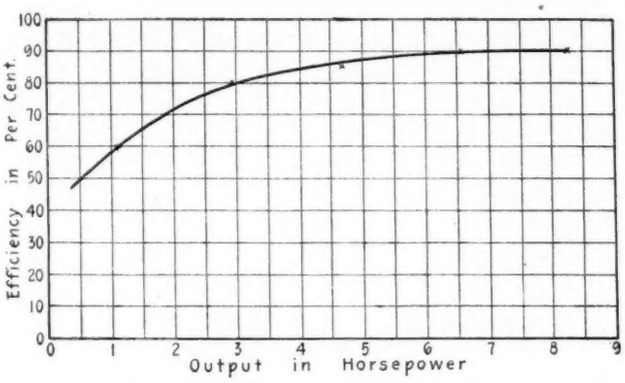


FIG. 3. EFFICIENCY CURVE FOR MOTOR

means of a prony brake. The platform scale available for the test has a maximum capacity of 200 lb. What is the shortest length of arm that the brake could be designed for?

Improved Girtanner Ash Conveyor

Most large power plants utilize some kind of ash conveyor in conjunction with their boiler plant. Many of these are actuated by one or more steam jets which draw the ashes through a horizontal pipe and discharge them through a vertical pipe into an ash tank. The ashes and clinker quickly wear through the metal of the pipes, especially at the bends, and various devices have been used to reduce this trouble.

Several improvements have recently been made to the Girtanner ash conveyor, manufactured by the Girtanner Engineering Corporation, 1400 Broadway, New York City. Beginning at the air intake on the inner end of the ash pipe, an iron grating is supplied to prevent foreign materials from falling into it. The opening of the intake member is made 50 per cent. greater in area than the pipe. The horizontal pipes are now made in 18-, 24,- 30-, 36-, 48-, 60- and 72-in. standard lengths. This facilitates making up a system quickly with suitable lengths, thus avoiding the necessity of making a special length for any particular installation. These lengths are made with a flange at each end and are bolted together by ⅞-in. bolts. The joint is made tight by means of a ½-in. round asbestos gasket that fits in a diamond-shaped groove cast in the face of the flange. When the flanges are brought metal to metal a ⅛-in. space is left between the upper flange faces outside the gasket. This is to permit the gasket to squeeze out on this side and thus make a tight joint.

A clever idea has been worked out in the design of the ash intake openings. These openings are usually desired opposite the center of the boiler setting. In order to bring them there an intake tee has been designed 36 in. long with the intake opening 3 in. out of center. Thus if the center of the intake opening is 3 in. short of the desired position, the intake tee can be turned end for end. In case this does not bring the opening in the desired position the difference can be

adjusted by means of the cover plate, the opening in which is also out of center and has an adjustment of 1½ in. by turning the plate end for end. The joint between the cover plate and the intake tee is made with asbestos gaskets that fit in diamond-shaped grooves. This arrangement permits of any adjustment within one inch at any part of six feet. An intake cover fits in the cover plate, the top coming level with the flooring and the inside being fitted with a curved plate that completes the circle of the pipe, thus preventing a pocket at the covers.

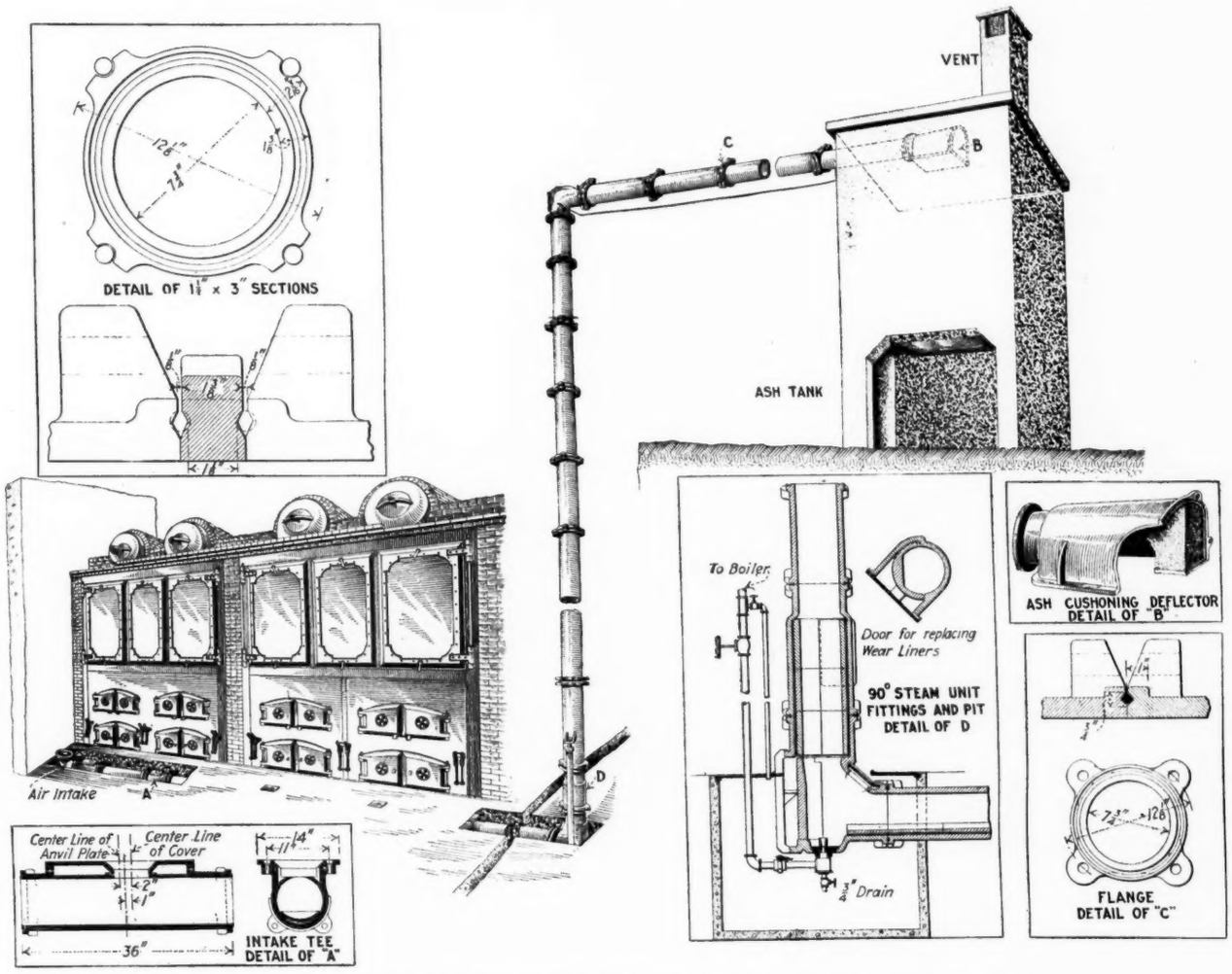
The entire bottom of the horizontal pipe is reinforced by liners, made in 18- and 24-in. lengths, which are inserted into the pipe through the intake openings. When worn out they are removed through the same opening.

Where the pipe turns from the horizontal to the vertical a special elbow is used. This is fitted with an inspection door through which a target plate is placed to receive the impact of the heavier pieces of ashes and clinker. A section of vertical pipe is bolted to this elbow and it is lined with split metal bushings, each 8 in. long; the lower one resting a shoulder in the elbow also forms a joint with the target plate. These four-piece bushings can be removed and replaced when worn, through a door in the vertical section of pipe, which is made of such diameter that the liners maintain the same inside diameter as the main pipe itself.

At the bottom of the elbow a steam nozzle is fitted in a plug. The nozzle is hexagon so that it can be removed for examination or replacement through an opening without breaking the steam pipe connection. It can also be removed from the outside of the elbow, but the steam connection would have to be broken. Water that may accumulate in the system is automatically discharged through a specially designed valve in the pocket that is formed for the reception of the nozzle.

In case it is necessary to remove the elbow and vertical liner section, provision has been made for holding the riser pipe in position. This is accomplished by two upright columns, one end resting on a suitable foundation; the other end of each is fitted with a plug in which a screw is fitted. This screw also fits into a lug cast on the upper section of the riser, and by screwing down the lower nut the weight of the vertical pipe is sustained by these columns. The lower sections are then easily removed.

On top of the ash bin a deflector box is arranged on the end of the pipe. This is capped at the outer end, and to prevent the cap from being worn through a shelf is cast on the inside bottom of the box and on this the ashes pile. This accumulation of ashes soon fills the end of the box, thus protecting the head with a baffling of ashes. The head is removable and is bolted to the deflector box.



GENERAL LAYOUT OF ASH-HANDLING SYSTEM AND DETAIL OF IMPROVED PARTS

Sudden Peak Loads on Chain-Grate Stokers

By H. F. GAUSS

Pertinent features affecting the design and operation of chain-grate stokers, with a chart for determining the proper air supply for fuels of various heat values.

AMONG power-plant equipment no piece of apparatus is attracting more attention at the present time than the forced-draft stoker. The term "normal rating" as applied to a steam boiler no longer limits its capacity, and is retained principally as an index to the amount of heating surface contained. Continuous operation of steam boilers at from 200 to 300 per cent. normal rating is now common, and stoker installations must be designed to burn sufficient coal to produce this rating.

There are two general classes of power-plant installations: Those having a steady or uniform load throughout their operation and those subject to extreme peak loads that must be met on short notice. The larger number of installations fall in the second class. A frequent complaint heard in boiler rooms is, "They slam on certain equipment all at once and without warning, and there's the devil to pay to hold steam." So it is squarely up to the designer to produce boiler and stoker equipment that will successfully handle emergencies of this nature.

Air Supply and Grate Area

The problem presented by the plant with a steady load resolves itself into a question of air supply and grate area. Perfect combustion is secured by properly mixing the correct amount of air with the fuel to be burned in the proper place and at the proper temperature. Failure on the part of such an installation must be due to incorrect air supply or insufficient grate area.

The plant with the peak load to meet, presents an additional problem. It must be capable of picking up a sudden extreme load easily and quickly, which can be accomplished only by increasing the rate of burning fuel on the grate. Proper manipulation of the feed water and auxiliary apparatus will help in the initial stage, but the primary object that must be accomplished is the burning of sufficient fuel at a sufficient rate to produce the necessary heat for generating steam to meet the demand. Again, there are but two causes for failure on the part of the stoker, and they are insufficient air and insufficient grate area.

There is a limit to the velocity at which air can be successfully forced through a grate. A certain time element is essential to the maintenance of the combustion temperature, and the proper mixing and contact of the air with the fuel and unburned gases liberated. When air moves so rapidly through the grate that this time element is not provided, the fire is blown out instead of the combustion being aided.

It is possible to blow out a fire by jetting through it a supply of air in itself insufficient for proper combustion, but driven through the grate at such a high velocity that combustion has not time to take place before the fuel is cooled below the point of ignition. This condition frequently obtains when high rates of combustion are attempted with forced-draft stokers by raising the pressure in the windbox until the air is forced through insufficient openings in the grate at high velocities. Given a grate with a certain percentage of air space, there is then a limit to the amount of a certain kind of fuel that can be burned on it. Therefore, to meet a sudden peak load a grate must have a percentage of air space and an area such that the necessary rate of combustion can be obtained with the air flowing through the grate and fuel bed at velocities low enough to permit of proper combustion. The question at once arises, What is the limiting air velocity?

No definite formula can be given for finding this limiting velocity because a number of factors affect the solution. They are principally the character of the fuel and the means provided for dissipating the air through the fuel bed. Again, the stage of combustion has a great deal to do with the velocity at which air may be delivered to a fuel bed. During the early or ignition stages there is much more danger of blowing out the fire by excessive air velocity than after the volatile has largely been driven off and the carbon has reached incandescence; hence the necessity of controlling the air supply to the progressive zones of the grate. In fact, in burning certain grades of fuel such as lignites and anthracite culm on chain-grate stokers, it has been found advantageous to introduce an induction zone for igniting the fuel. Directly under the ignition arch is a section of the stoker provided with a tuyere by which some of the hot gases from the furnace can be drawn down through the green fuel, which is thus ignited, the induction fan discharging its gases into the succeeding pressure zones.

Control of the Air Supply

Evidently, the term "rate of combustion per square foot of grate area" means very little when it is determined by dividing the total fuel burned per hour by the total grate area. An important part of successful stoker design is to get the fuel ignited and burning while in the ignition zones of the furnace, so that after it has reached the real combustion zones, no time is lost in igniting green fuel and the necessary high rate of combustion can be obtained. For instance, consider a forced-draft chain-grate stoker 12 ft. long. The stages of ignition, release of volatile matter and combustion of fixed carbon must take place in the order named and the time necessary for each must be properly provided. During the early stages the weight of fuel consumed is relatively small, in the middle stages it is high and in the last stages it again becomes low. In a stoker burning fuel at a rate of 75 lb. per square foot per hour the actual maximum rate may be as high as 150 lb. per sq.ft. of grate area in the middle zones of the stoker. This emphasizes the necessity of perfect control of the air supply to the successive zones, and also illustrates the fact that air can be successfully driven through certain sections of a stoker grate at much higher velocities than through other parts of the same grate.

There is another important consideration in determining the amount of air necessary for the required rate of combustion. An increase in velocity of air passing through the grate is at the expense of an increase in static pressure in the windbox. To deliver a greater

quantity of air against an increased pressure an increase in fan speed is necessary. A condition may easily be reached whereby the windbox pressure is raised to such a point that less air is actually delivered but at a much higher velocity. For instance, the accompanying table, copied from a blower catalog, shows that a 16-in. fan running at 2750 r.p.m. will deliver 5400 cu.ft. per min. of air against a static pressure of 0.5 in., and at a speed of 3250 r.p.m. it will deliver 6400 cu.ft. per min. against the same pressure. At the increased speed the same fan will deliver only 5500 cu.ft. per min. against a pressure of 1 in. and 4600 cu.ft. per min. against a pressure of 1.5 in. Hence it will not do to assume that since a fan has a certain range of capacity it will be capable of supplying these quantities of air against a static pressure of 0.5 in. through a grate, with the resultant rates of combustion, because the increase in air velocity can be obtained only by increasing the static pressure of the windbox.

It is therefore essential that the grate itself be provided with sufficient air space to permit the maximum amount of air to pass at a predetermined static windbox pressure, and that lower rates be obtained either by reducing the windbox pressure or by providing dampers to limit the volume of air allowed to pass from the windbox through the grates, which of course will raise the windbox pressure, assuming that the fan is run at the same speed.

The accompanying chart makes it possible to find the area of air space required for a given boiler output, taking into account the various factors. For example, suppose that it is desired to find the air-space area in the grates of a boiler of 850 hp. burning fuel having a heat value of 10,000 B.t.u. per lb. and operating at an efficiency of 70 per cent., assuming 50 per cent. excess of air and an air velocity of 2100 ft. per min. Using the alignment chart in the blank space at the right, locate 70 on the scale of boiler efficiency and 10,000 on the scale of heat value and join the two by a straight line, continuing it until it cuts the right-hand scale. The point thus found on this scale will represent 4.8 lb. of fuel per boiler horsepower-hour.

On the lower line of the upper right-hand quadrant locate 4.8 and proceed vertically to the diagonal marked

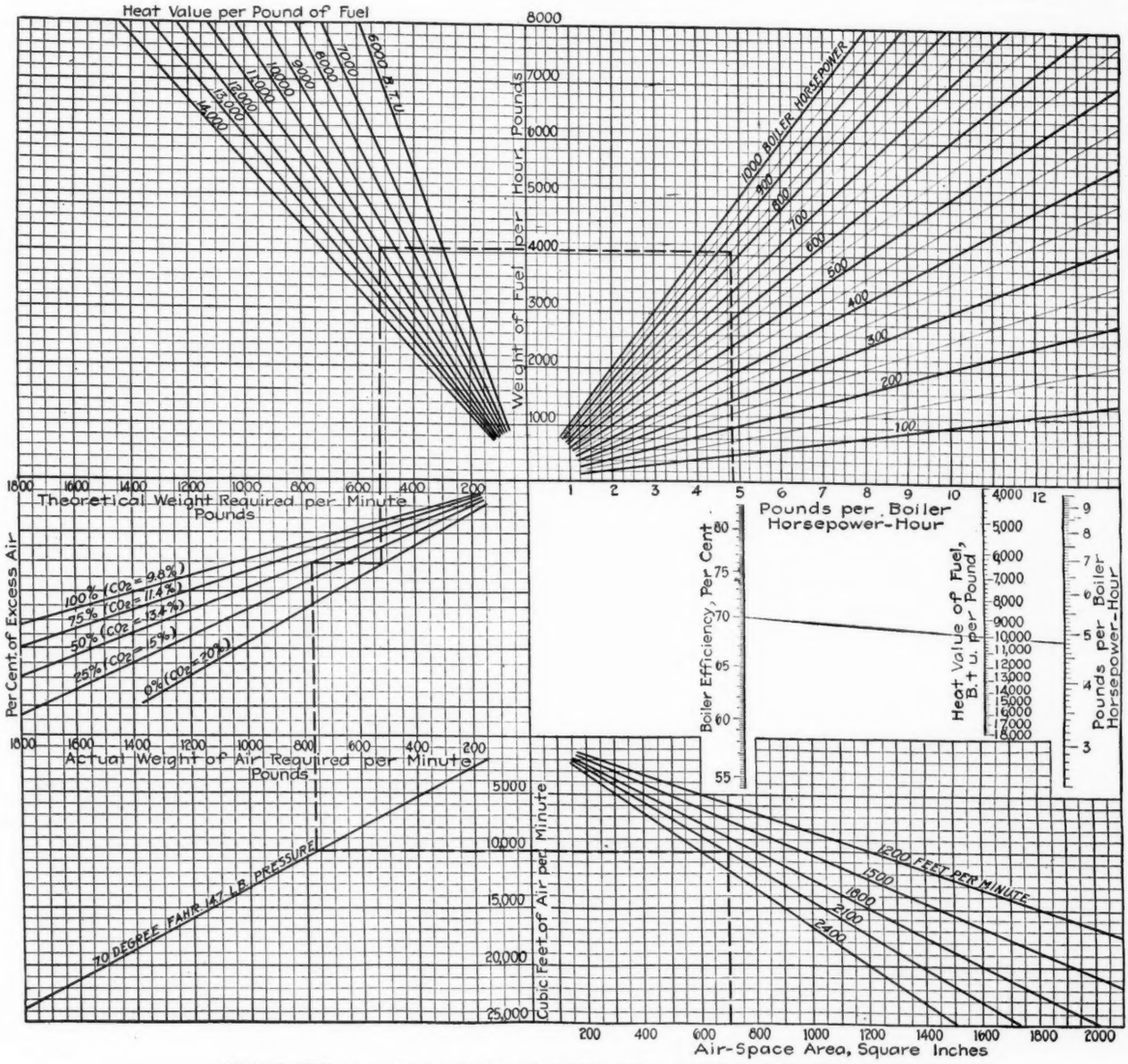


CHART FOR FINDING AIR-SPACE AREA FOR A GIVEN BOILER OUTPUT

850 boiler horsepower. Then turn horizontally to the diagonal representing 10,000 B.t.u. in the upper left-hand quadrant. From this point drop vertically to the diagonal representing no excess of air (20 per cent. of CO_2) and then follow horizontally to the diagonal representing 50 per cent. excess of air. Thence drop vertically to the diagonal in the lower left-hand quadrant, and then turn horizontally to the lower right-hand quadrant until the diagonal representing an air velocity of 2100 ft. per min. is reached. From this last point drop vertically to the bottom scale, where the value 700 will be indicated, meaning that an air-space area of 700 sq.in. is required.

Tabular Data and Graphic Charts Available

There is much information available at present in the shape of tabular data and graphic charts giving the draft required to burn various kinds and grades of fuel on various types of grate. The information thus obtained is valuable and can be used as an index to the pressure in the windbox or draft over the fire required. In the final analysis, however, the air space in the grate must be considered, as it is possible that the amount of air required for the rate of combustion desired cannot be forced through the grate at reasonable velocities, and when the fuel bed is added with its resistance, failure inevitably results. Herein is the principal cause of failure of stokers to pick up peak loads promptly. The air is available, but it cannot be delivered to the fuel bed at velocities to produce the necessary combustion.

In general, it may be said for forced-draft stokers that by far the most desirable condition is a grate so designed that a sufficient volume of air can be delivered through the fuel bed at a static pressure in the windbox of never to exceed 1.5 in. This of course would limit the fuel bed to a thickness of not more than 12 in., which in itself is a desirable feature, inasmuch as the formation of large clinkers is not as common with these thinner fuel beds as it is with very thick ones, and the percentage of carbon in the ash from a thin fuel bed has been found to be materially less.

No more serious mistake can be made in the selection and design of a stoker than the assumption that forced draft will eliminate the necessity of a large stack. The practical limit of forced draft is a balanced condition in the furnace, and preferably a few hundredths of an inch of draft rather than pressure. From this point on the chimney must do the work. The fan producing forced draft overcomes the resistance of the grate and fuel bed, but cannot go farther without the danger of excessive blowing out through unavoidable crevices in the setting and filling the boiler room with disagreeable smoke and dangerous gases. The height of the stack can be reduced by an amount necessary to produce draft enough to pull the air through the grate and fuel bed, but no more, and its diameter must be sufficient to handle the volume of gases evolved. The only advantages accruing from the use of forced draft are the gain by establishing a balanced condition in the furnace and reducing the leakage of cold air into the furnace through unavoidable crevices and the easier means of controlling the amount of air delivered through the grates, which in turn facilitates the picking up and dropping of peak loads.

One of the problems in the operation of stokers is the disposal of ash in such a way that the formation of large clinkers will be avoided. The violent agitation of a fuel bed tending to mix the ash with unburned fuel is sure to produce clinkers, which fuse around unburned coal, preventing its final combustion and resulting in a high percentage of carbon in the ash. This result can be seen easily by breaking open a large clinker and inspecting the fracture.

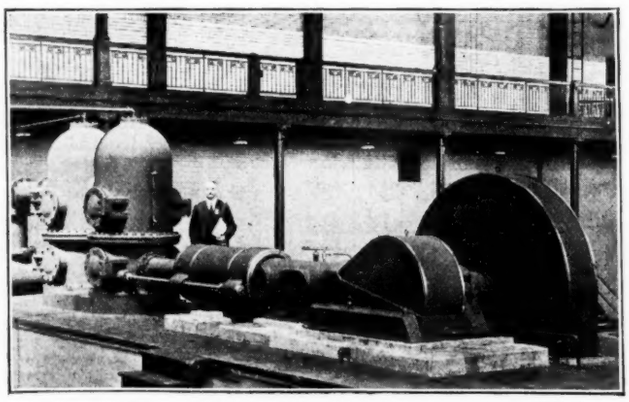
Chain- and traveling-grate stokers are perhaps the only types that do not produce clinkers of this kind. In the chain-grate, however, some means of keeping the side walls cool just above the top of the fuel bed is desirable to prevent the adherence of ash to the side walls. The ash tends to build outward over the grate, forming a clinker that obstructs the movement of the fuel and bares the grate behind it. Cooling of the side walls has been effected successfully by means of water-cooled clinker plates.

SPEED, PRESSURE AND VOLUME OF AIR DELIVERED BY 16-IN. FAN

Speed of Fan, R.p.m.	Static Pressure, Inches of Water							
	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
	Volume of Air Delivered, Cubic Feet per Minute							
2750	5800	5400	4900	4400	4100	3600	3100	....
3250	6700	6400	6000	5500	5100	4600	4200	3800
3750	7600	7300	6900	6500	6100	5700	5350	5000
4250	8500	8200	7900	7550	7200	6800	6400	6100

"Unaflow" Pumping Engine

Those who attended the recent convention of the American Water Works Association at Buffalo were afforded an opportunity of seeing at the Porter Avenue pumping station a 3,000,000-gal. "Unaflow" pumping engine. This is of the horizontal type having one steam cylinder and one double-acting plunger pump. Its normal working water pressure is 100 lb. per sq.in., and the suction lift is approximately 15 lb. plus the



"UNAFLOW" TEST PUMPING ENGINE AT BUFFALO

friction in about 60 ft. of pipe. The pressure on the steam end is 235 lb. and 100 deg. superheat.

To develop a pump that could be combined with and utilize the advantageous features of the "unaflow" principle required that due consideration be given to proper channels for passing the desired amount of water to and through the pump with the least practicable amount of deflection and disturbance of the flow. The pump must be provided with passages ample and direct, so that there will be no reversal of flow; with plungers properly proportioned and formed to cause a minimum disturbance; with suitable suction and discharge air chambers properly located; with pump valves that will deflect the direction of flow as little as possible, that will operate quickly and quietly at all pressures and economic speeds of the engine, and, furthermore, that will be durable and lasting in operation. Tests of this engine will be made later and the results made public.

EDITORIALS

What Should Be the Maximum Length of a Longitudinal Joint in a Boiler?

THE Massachusetts Board of Boiler Rules prescribes that:

A horizontal return-tubular, vertical-tubular, or locomotive-type boiler shall not have a continuous longitudinal joint over twelve (12) feet in length.

The Boiler Code of the American Society of Mechanical Engineers says:

In horizontal return-tubular boilers with lap joints no course shall be over 12 ft. long. With butt-and-double-strap construction longitudinal joints of any length may be used, provided the test specimens are so cut from the shell plate that their lengthwise direction is parallel with the circumferential seams of the boiler and the test meets the standards prescribed in the specifications for boiler-plate steel.

The restriction in length applies in the Massachusetts Rules to three types of boilers—horizontal return-tubular, vertical-tubular and locomotive—whether the joint is of the lap or butt-and-strap type. In the A. S. M. E. Code it applies to only one type of boiler, the horizontal return-tubular, and to that only when a lap joint is used.

Both Rules and Code inhibit the use of a lap-riveted longitudinal joint over twelve feet in length on a horizontal return-tubular boiler.

Under the A. S. M. E. Boiler Code a butt-and-strap joint of any length may be used on any kind of a boiler. In Massachusetts such a joint may not be over twelve feet long on a horizontal return-tubular, vertical-tubular, or locomotive boiler.

No restriction is placed by either authority upon the length of longitudinal joint that may be used in the shell or drum of a water-tube boiler. Is this because they do not come in contact with the fire and are not subject to such severe temperature changes? But neither does the shell of a vertical-tubular or locomotive boiler.

What is it that makes a joint over twelve feet in length dangerous? The makers of the A. S. M. E. Code seem to suspect that on account of the limited number of mills having wide rolls and the consequent difficulty of getting very wide plate, the boiler manufacturer may roll the plate endwise in order to get a long course and thus put the tensile stress upon it crosswise of the grain. Some of those who have discussed the subject compare the weakness caused by a long joint in a boiler to that caused by a long uninterrupted course in masonry and urge that it is better to break the line occasionally, without being very specific as to the kind of weakness produced and the manner of producing it.

Boiler-insurance companies say that their records indicate that the long joint is a source of weakness and has been the cause of numerous explosions.

It would be very satisfying if we could have some information as to just what happens with a long joint; whether the dangerous tendencies introduced by its length are counteracted by making it of the butt-and-double-strap construction, as appears to be assumed by the makers of the A. S. M. E. Code, or if these perversities persist even in that type of joint, as appears to be feared by the Massachusetts Board of Boiler Rules. If long joints are dangerous upon vertical and locomotive boilers in Massachusetts, they are dangerous anywhere. Either the Massachusetts Rules are too exacting or the A. S. M. E. Code is too lax.

This is one of the main points of difference between the Massachusetts Rules and the A. S. M. E. Code. It is not a political or geographical but a plain engineering question. If one or the other position is not so decidedly stronger than the other that it can be so proved in a clean, unbiased engineering argument, then in the interest of harmony and efficiency and uniformity there ought to be a compromise which will wipe the difference out, for it is not of enough importance to remain as a split in American practice. If one view is capable, by engineering argument, by the statistics of explosions or by other means, of being demonstrated the more correct, it should be written into both codes regardless of what they have decreed or been satisfied with in the past.

Let us have a plain engineering discussion of the question, Why Is a Long Longitudinal Joint Dangerous? What do you know or think about it? If we can find this out, we can better decide whether it should be allowed upon vertical and locomotive boilers, and whether its dangerous proclivities are obviated by making it of the butt-and-strap type. It is to everybody's advantage to clear up the points of difference between the two codes.

Superheated Steam—Why Not?

WHAT are the advantages in using superheated steam? Can it be used successfully with reciprocating engines of the Corliss and slide-valve types? Have lubricating troubles been overcome when using superheated steam with reciprocating units, and, if so, how? Will engines having ordinary cast-iron cylinders and valves withstand the effects of superheated steam?

These are pertinent questions in which the steam engineer of today is interested. The average engineer will state that the superheated steam is confined to steam-turbine power plants, that the use of superheated steam in reciprocating engines is confined to those having the poppet type of valve, and that its use with the ordinary type of reciprocating engine is not general.

It would be difficult to determine the exact percentage of power plants using superheated steam, but it is assumed that of the total horsepower developed in this country by steam, perhaps only thirty per cent. is developed by units using superheated steam, and this is mostly confined to steam-turbine plants. Thus, it is evident that although most turbine plants employ superheated steam, the number of such plants is a comparatively small percentage of the total steam plants. In other words, approximately seventy per cent. of the steam power developed in this country is produced by units using saturated steam. Why should this be?

Two arguments have been advanced against the use of superheated steam in reciprocating engines; namely, difficulty of lubrication and the inability of the metal commonly used in making the cylinders and valves to withstand the high temperature. But is it not a fact that suitable oil is procurable for use with high-temperature steam and that proper means for lubrication is available? Furthermore, is it so much the metal of which a cylinder and its valves are made as it is the degree of care that is exercised in the maintenance and operation of reciprocating engines when using superheated steam?

As a matter of fact, one manufacturer of superheaters states that in the application of over eighteen million horsepower in superheaters for stationary, marine and locomotive service, he has found that from two hundred to two hundred and fifty degrees superheat can be safely and satisfactorily employed with successful lubrication and without material change in the metal used in the cylinder valves, fittings and pipings.

It has been several years since the subject of using superheated steam has been discussed in technical journals to any extent, and it would seem that in view of the present coal situation and the consequent desirability of effecting economy wherever possible, there is still much to be desired in the adoption of superheat in plants operating reciprocating engines.

Undoubtedly, there are some of our readers who are operating reciprocating engines and using superheated steam. It would be of interest to other readers to know just what troubles they have had, how they have overcome them, and general data regarding the use of superheat in their plants, how they have solved the lubricating question, and how the material of which the engines are made has stood up under the high temperature.

Material for Turbine Blades

IF THE steam and speed conditions that turbine blades have to serve under were always the same, some one metal for their construction might be found and used. But conditions widely vary, and therefore a wide variety of materials are used. There is not a turbine builder here or abroad who would not be overjoyed to find, "the very best material." But a standard material has not been found.

Elsewhere in this issue appears an article which in part treats of this subject with particular references to monel metal. It brought the question of turbine-blade materials again before us, and the present practice, as told in communications from nearly all the builders in this country, is of interest to all power-plant men.

Richard Rice, of the General Electric Company, well expresses the matter when he says: "There are a number of materials which are eminently suitable for use as turbine buckets, and the use of these materials depends entirely upon the steam conditions and the particular place where the buckets are to be used, the stresses in the buckets, both centrifugal and bending, also upon the cost of the material, not raw but in the condition of a finished bucket."

W. J. A. London, of the Steam Motors Company, who has had considerable experience in steam-turbine design in America, the British Isles and on the Continent, says, " . . . as far as I have been able to find out the best experts in steam-turbine design in this country or in Europe are about as much up in the air as to what to use for turbine blading as they ever were." In 1913 he found in Germany no two shops using the same material. The materials used ranged from thirty per cent. nickel steel to soft Swedish iron. Experience has convinced Mr. London that for impulse blading, generally speaking, soft steel or iron is admirably suited. Relative to monel metal he says that difficulties are had in getting uniformity in characteristics. These were experienced by the builders of the Parsons turbines in England; and Mr. London believes the United States Navy's experience with monel for propellers has demonstrated that certain consignments of the metal are satisfactory, but the quality of this metal, being a natural alloy, is erratic in its characteristics. But, the tendency of practice is toward higher pressures, temperatures and stresses, and for these monel is one of the materials excellently suited. Mr. Rice points out that for high superheat and where the centrifugal stress or the combined centrifugal and bending stresses are extremely high, there is nothing equal to some steel alloy having a high elastic limit. The cost, of course, is high.

Experience is showing that phosphor-bronze blading for reaction machines under high pressure and superheat lives up unexpectedly well. For example, in the high-pressure stages of a large Westinghouse type machine in one of the Chicago stations where two hundred and forty pounds pressure, gage, is carried at the throttle, with two hundred degrees superheat, no appreciable evidence of corrosion or erosion is apparent after a year's operation. In the exhaust-end blading, where the mechanical stresses are high and the temperatures low, low-carbon, five per cent. nickel electric furnace steel is performing satisfactorily in machines of this type. Of monel, J. T. Johnson, engineer, turbine department of the Westinghouse Electric and Manufacturing Company, says: "The cost of the metal and of manufacture of the blades is considerably higher than the cost of steel or bronze blading. It is probably not any cheaper nor as good for high-speed blading as pure nickel, which is now available." Mr. Wallace, of the De Laval Steam Turbine Company, makes the point that it (monel) is severe on dies.

Maynard D. Church, chief engineer of the Terry Steam Turbine Company, points out that a turbine that stands idle much of the time should have its blades of such material that the edges of the blades will not be rusted away, thus greatly impairing the machine's efficiency. In velocity-stage machines he finds monel among the very best for the first moving row of blades, following this with copper-nickel alloy, with extended brass for the low-pressure blades of condensing machines.

It is our understanding that the Fore River Shipbuilding Company is now making large quantities of monel blades by machining them out of the solid square stock.

So one sees that the art has not yet got where it can be said that any one material is standard.

When cutting in a boiler to a header, care should be exercised. The steam pressures should agree before opening the valves, and they should then be opened slowly.

Is there anyone about your plant who is interested in the amount of coal in the ash pile?

Correspondence

Difficulty Experienced in Getting a Generator up to Full Voltage

In the issue of *Power* for Apr. 22 appears a letter from Robert Tomlinson asking for an explanation of the strange behavior of a compound-wound generator. Consideration of all evidence leads to the conclusion that the trouble developed from the cross-connecting of the armature leads, probably at the brush-holder studs when the machine was reassembled after repairs, an error easily made on many machines. An analysis of the situation revealed that there were four elements only that had a bearing on results. These are stated as follows: (1) The cross-connections of the armature leads; (2) the excitation of the field from a separate circuit; (3) the restoration of armature leads to their proper position; (4) the final flashing of the field with the battery.

Fig. 1 shows the connection of the generators as they should be. Suppose, then, that the armature leads are

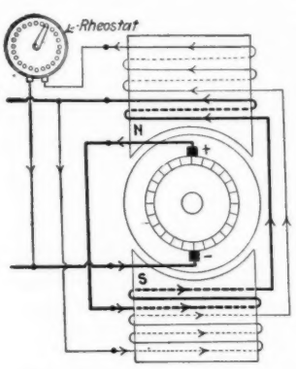


FIG. 1. GENERATOR CONNECTIONS MADE CORRECTLY

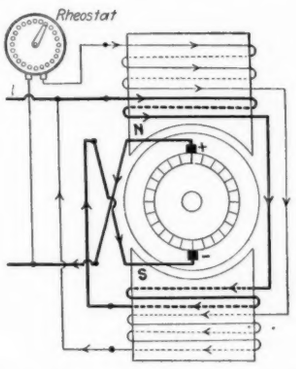


FIG. 2. GENERATOR WITH ARMATURE CONNECTIONS CROSSED

reversed at the terminal board, as in Fig. 2; this reverses the direction of the current through the series- and shunt-field windings. The reverse current tends to set up a magnetic flux in opposition to the residual magnetism of the polepieces, which creates a balanced condition between the two, consequently the generator cannot build up. Flashing the shunt field from an outside source will not help matters any, even though the residual magnetism of the polepiece is reversed, since this would reverse the polarity of the generator, consequently the current through the field windings, which is a condition similar to that in Fig. 2.

There are probably two reasons for the generator building up to only approximately half voltage when excited from the 210-volt circuit: First, the exciting voltage was lower than the normal voltage of the generator, and second, the field rheostat was probably all cut into the shunt-field circuit, a condition that could have been brought about easily by someone turning the rheostat in an effort to get the generator up to voltage.

When the armature leads were reversed, this brought about the right condition, as shown in Fig. 1, but the polarity of the polepiece had been reversed when the field coils were excited from an outside source, consequently the generator built up the wrong polarity. Of course this was easily changed by sending a current through the field coils in the opposite direction. It will be noted that if the connections of the generator are correct to build up one polarity, the machine will also build up the opposite polarity, it being only a matter of what polarity the residual magnetism has in the polepieces.

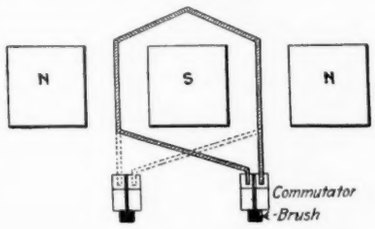


FIG. 3. TWO POSITIONS OF ARMATURE COIL LEADS

O. B. CRITCHLOW.

New Brighton, Penn.

I have seen cases like that described by Mr. Tomlinson. The machine probably has the brush studs in line with the space between the field poles, and the armature winder made a mistake and connected the leads the wrong way, as shown in Fig. 3. The full lines show one possible position and the dotted lines the other position. If the full-line connections would make the right-hand brush positive, the dotted connections would make the left-hand position positive.

A generator will not build up if the relation between the armature and field connections is wrong, no matter what polarity the residual magnetism may have; any voltage generated by the residual magnetism will set up a current in the field winding in such a direction as to oppose and tend to destroy the residual magnetic field.

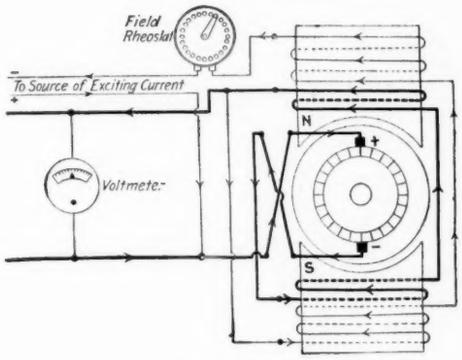


FIG. 4. SHUNT-FIELD WINDINGS EXCITED FROM OUTSIDE SOURCE

When the machine was separately excited, the low voltage may have been due to a load on the machine and the load current was flowing in the reverse direction to the series field, its effect being in opposition to that of the shunt field. This opposition would have existed no matter which way the current was sent through the shunt field. Now, when the armature leads were

crossed, everything was made right and the relation between the armature and field is now correct, and the machine will build up no matter which way the residual magnetism may be. If the voltmeter shows a reverse voltage, a change of residual magnetism will correct this.

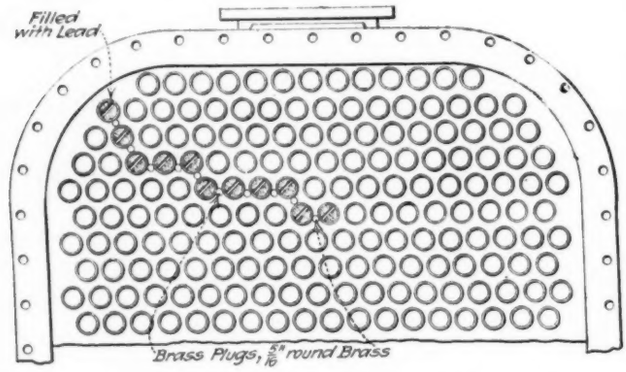
ALBERT E. CARPENTER.

Adams, Mass.

[In a number of discussions submitted on the difficulty experienced by Mr. Tomlinson in getting the generators to build up, a great deal of stress was laid on the series and shunt-field windings being in opposition. However, it is evident from Figs. 1 and 2 in Mr. Critchlow's discussion, since the difficulty was remedied by crossing the armature lead, that the field windings were not connected in opposition. Furthermore, if the series and shunt windings were connected in opposition, the effect of the series winding would be practically negligible until a load was put on the machine. The probable cause for having to cross the armature lead is accounted for in Mr. Carpenter's discussion. However, why the machines only generated about 110 volts with the shunt-field coils excited from a 210-volt circuit is very likely due to connecting the exciting circuit as in Fig. 4. If a connection is made to an external source of exciting current, as in the figure, with the armature leads connected so that the machine cannot excite its own field, the voltage generated in the armature will oppose that applied to the field coils and the machine will generate only approximately 50 per cent. of its normal voltage. With the armature and field windings connected in their correct relation, connecting the machine to an outside excitation source, as in the figure, will generate a voltage in the armature of the same polarity as the exciting current. This is made evident by crossing the armature lead in the figure. The result of this connection is to increase the voltage above normal about 25 per cent. However, the increase is determined by the saturation of the magnetic circuit.—Editor.]

Plugged Cracked Condenser Tube Sheet

The accompanying sketch shows how I repaired a cracked tube sheet of a surface condenser. I removed the tubes following the crack and used the ferrules as



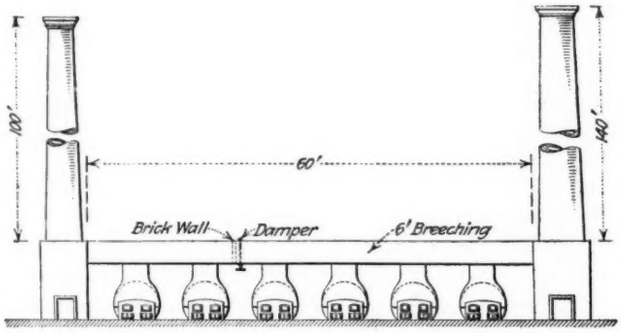
CRACK IN CONDENSER HEAD MADE TIGHT WITH PLUGS

plugs, first filling them with lead. After screwing them in solid, I drilled and tapped into the crack between the plugs for $\frac{5}{16}$-in. plugs, which filled up the space between the ferrule holes. After dressing with a calking tool, I had no trouble. THOMAS MULLIGAN.

Woodside, N. Y.

Chimney Had Back Draft

The owners of a large distillery in Kentucky recently sold their plant to a newly organized manufacturing concern. When the officials of the new company attempted to try out the plant, they were unable to get satisfactory results. The boiler equipment con-



SMOKE CONNECTIONS TO CHIMNEYS, BRICK WALL AND DAMPER

sisted of six Scotch marine boilers, five of 250 hp. and one of 300 hp., all with the dutch-oven type of furnace. The trouble seemed to be a lack of sufficient draft, and in the hard firing used in the attempt to get results from the boilers the front fire-doors had been warped by the heat. In boilers Nos. 1, 2 and 3 it was practically impossible to get a hot fire, the coal charging and smoldering in a dead mass.

Having been sent to investigate and, if possible, remedy the trouble, I found the following peculiar condition: There were two stacks, one 100 ft. high, 5 ft. in diameter, the other 140 ft. high, 6 ft. in diameter. These stacks were connected by a cylindrical breeching about 60 ft. in length and 6 ft. in diameter, to which the uptakes of the boilers were connected.

There was a cutoff damper between boilers Nos. 2 and 3, but by getting inside the breeching I found that it was impossible to close this damper by hand, and a heavy current of air was flowing constantly from the smaller to the larger of the stacks. With six men and a battering ram I managed to close the damper; then I had a solid brick wall built at a distance of two inches from the damper inside the breeching, at the same time packing the space with asbestos cement. This gave a practically air-tight wall, separating the breaching into two independent sections and isolating the stacks. It was then found by testing that the separated stacks gave sufficient draft for the connected boilers and it was possible to operate at a high rating without trouble.

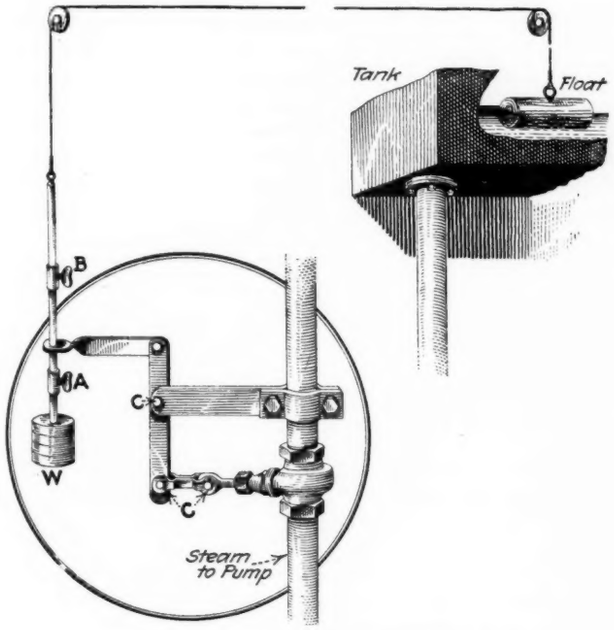
Before the change was made, it was impossible to get higher than 4 per cent. CO_2 on any of the boilers, and it was necessary to build a large fire in the base of the smaller stack to get enough draft to maintain fires in boilers Nos. 1, 2 and 3. After putting in the wall the boilers were operated at from 12 to 14 per cent. CO_2 and without the use of fires in the base of stacks to aid the draft.

Of course the trouble was due to the taller stack of larger diameter having a stronger draft, which caused a down-draft in the smaller stack, and as the breeching was filled with air from this source there was very little draft available at the furnaces. EDWIN L. WHITE.

Louisville, Ky.

Float Control for Pump

The illustration shows a tank-pump float control that is about as simple as could be put together. The float is a log heavy enough to overbalance the rod, weight and connecting line. The limits *A* and *B* can be set so that



DETAIL OF VALVE GEAR

the pump will not begin working until the tank is nearly empty and will stop when the tank is full or at any other point desired. JAMES E. NOBLE.

Portsmouth, Ont., Canada.

Water-Column Blowoff Valves

On page 499 of the Apr. 1 issue of *Power* is a communication regarding water-column valves, which should be carefully studied before using water-column blowoff or drain valves of the globe type, as Mr. Pascoe recommends.

I do not approve of angle or globe valves being used on either the drain pipe from the water glass or in the water-column connections. The pocket beneath the seat forms a space for the collection of scale and mud and will plug up frequently unless blown out at regular intervals. With the pressure beneath the disk the valve will always open if the pipe is not choked up, somewhat as a check valve is opened.

Globe valves with composition disks are likely to rapidly cut away on the disks and seats and require frequent renewals and regrinding. Otherwise, with rough seats the disks will continue to leak and wear out rapidly. The proper way to connect a globe valve is to have the pressure beneath the disk, as the disk area is small and it is easily held to its seat by the pressure of the steam screw, therefore there is less strain on the bonnet than if the pressure came out on the other side of the disk. The valve stem can also be packed at any time. Where globe valves are used, I believe that it is advisable to use a valve with a brass disk.

A globe valve connected with the pressure on top of the disk is in my opinion dangerous. In one instance a valve so placed began to leak. Then the attendant applied a wrench on the wheel to screw it up tighter, and the bonnet was forced off. The reason was that the inside area of the bonnet was exposed to full boiler pressure, and this area being much greater than that of the under side of the disk, carried many times more pressure than would have been carried by the small portion of the disk that would have been under boiler pressure if the pressure had been under the disk. Adding the boiler pressure to that developed by screwing up the stem as tight as possible was more than the valve was capable of withstanding.

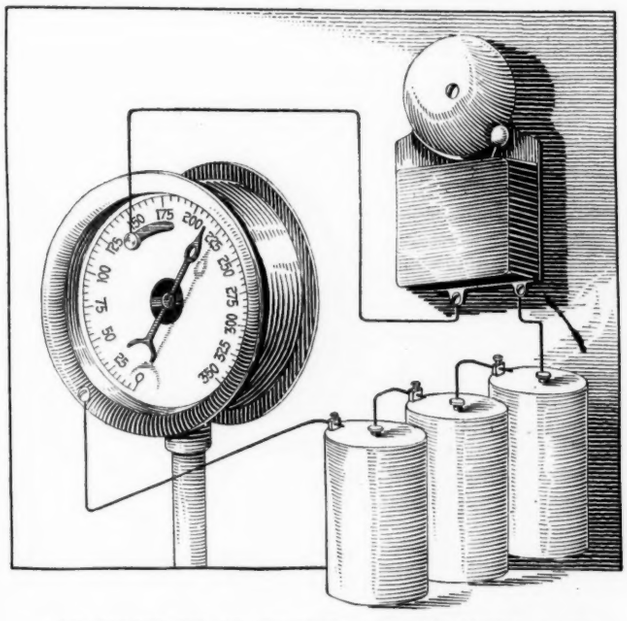
The pocket back of the disk will plug up with scale and mud, and the valve stem cannot well be packed while steam is on the boiler. The seats and disks will cut away, and the reason they don't start to leak sooner is because the steam pressure on a large area of the back of the disk holds it tightly to the seat, but when once started it is even worse than if the pressure were beneath the disk.

License and boiler laws of some states prohibit globe valves on water-column drain pipes, only gate or straightway valves being permited. R. A. CULTRA.

Cambridge, Mass.

Hydraulic Pressure-Gage Alarm

A pressure alarm attached to a hydraulic gage in a certain plant was made by drilling a small hole in the glass face of the gage in line with the travel of the pointer, through which an electric terminal was attached, as shown in the illustration. The other terminal was connected to the body of the gage. The bell can be set to ring at any pressure by adjusting the glass face of



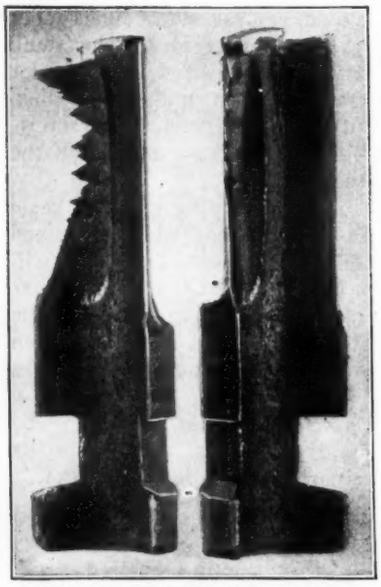
ARRANGEMENT OF CONTACTS ON PRESSURE GAGE

the gage. In this plant it is set at 175 lb. When the pressure drops to this point, the pointer completes the circuit and the bell rings, giving the alarm to the engineers in charge, who get into quick action to find the cause of the low pressure, as the plant will not operate very long at 175 lb. It requires 210 lb. to keep it in operation. J. A. LANDOLINA.

Memphis, Tenn.

Peculiar Erosion of Turbine Bucket

The illustration shows two views of a bucket taken from the first wheel of the second stage of a 1500-kw. Curtis turbine that had been in service five years. The edge of the bucket is worn away in the saw-tooth manner shown at the left and a deep groove is formed lengthwise of the bucket at about the middle of its width, as shown at the right. The erosion is so peculiar that I thought it would interest readers of *Power*. The other buckets in the same wheel were eroded in this same manner. The buckets in the other wheels, however, showed uniform wear, without the deep grooving.



EROSION OF TURBINE BUCKET

E. W. YORK.

Oil City, Penn.

Efficiency in a Paper Coating Mill

I have been intensely interested in power-plant economy for the last twelve years and have had the pleasure of making reductions in the cost of power in several plants. The maximum savings realized varied from 22 to 35 per cent., based on the cost per kilowatt-hour. These savings were difficult to obtain and required hard work for long periods of time; however, I have recently been able to make the biggest showing in a short period in a plant where it was not even suspected that any reduction could be made in power costs.

Expenses have not been reduced in the power plant, but the hourly capacity of the mill has been increased over 70 per cent. through improving the drying of the paper after coating. As the coating must be sufficiently dried so that it will not stick when it comes in contact with the guide rollers, and especially the apron, it is obvious that the quantity of paper turned out depends upon the drying efficiency.

One would naturally suppose that all that is required is very hot air, but I have discovered that this is not the chief essential. The drying depends in great part upon the humidity of the air; hence it was largely through making a study of this condition that the mill capacity was increased as mentioned. The weight of paper per pound of coal manufactured was increased from 0.6 lb. to 1.03 lb. approximately. In addition to this we have good reason to believe that we will be able to increase the paper output per pound of coal to 1.5 lb., or, say, 50 per cent. This has already been achieved under ideal conditions.

I would be very glad to tell the readers of *Power* just how the drying was done. However, it would be of little interest to those who do not understand the paper-mill game, so I merely offer this as a suggestion that the employers invite their chief engineers to coöperate with them in the manufacturing processes, also that engineers make a study of these processes with a view of preventing penny-wise and pound-foolish economy methods in the power plant.

What the manager or mill owner most desires is a good product and an attractive profit. Hence it is of special importance to the engineer that he guard against adopting such economic policies as may interfere with the manufacturing processes, with the results that the production be lowered both as to quality and quantity, which in turn results in less profit to the owner.

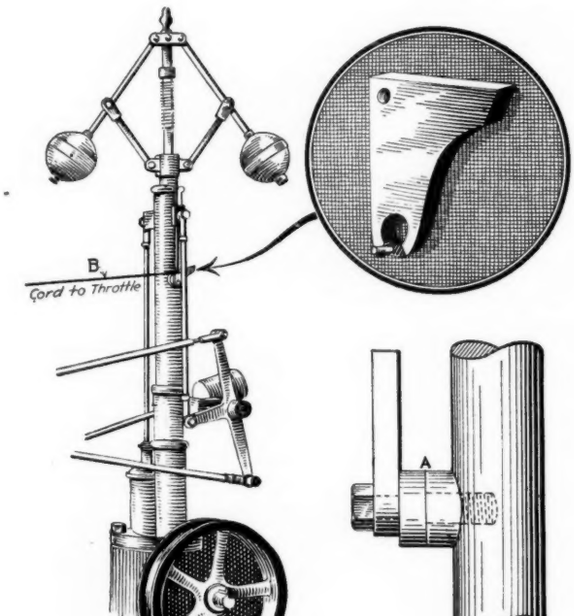
Of course it is essential that the engineer be in a receptive mood and that he display the attitude of being willing to help and not get on the wrong track in thinking that he is the only one who knows anything about it. It should be remembered that chief executives never like such an attitude.

WALDO WEAVER.

Franklin, Ohio.

Governor Safety Latch

A governor safety latch that has been used on several engines in my plant for about five years is shown in the illustration. It is always ready when applied properly, and there is nothing to get out of order. The latch is cut from a piece of quarter-inch iron plate. The collar *A* is made to fit the governor stand, which in my case is four inches in diameter. The cord *B* extends from the hole in the top of the latch to the throttle so that when the operator stops the engine he can pull the cord and hold the latch in place until the governor arm rests on it. The cord is then left slack so that the safety latch is ready to fall to one side as soon as the engine is stalled and the governor lifts enough to free it. A pin prevents the latch from falling too far in either direction.



HOME-MADE GOVERNOR SAFETY LATCH

H. H. FINCH.

Springfield, Mo.

Inquiries of General Interest

Advantages of Inertia Governors—What are the advantages of inertia governors over simple centrifugal shaft governors? C. B.

Inertia governors act quicker in adapting the point of cutoff to a change of load and are capable of a design in which the inertia and centrifugal effects are so combined that, for a change of load, the speed of the engine is held closer to the normal speed than when only centrifugal effect is depended upon.

Current Density for Electroplating—What current densities in amperes are used for electroplating? W. L. A.

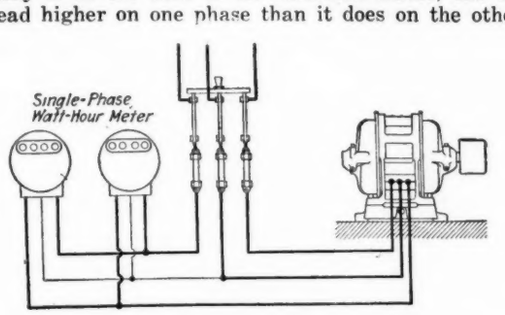
The usual densities employed for different metals are:

Copper, cyanide bath	3	to	5	amperes	per	sq. ft.
Copper, acid bath	5	"	10	"	"	" "
Nickel, double sulphate,	6	"	8	"	"	" "
Gold, Chloride in cyanide,	1	"	2	"	"	" "
Silver, double cyanide,	2	"	5	"	"	" "

Low current density produces a hard close grained surface and a high current density gives a softer, more open deposit which may present a powdery appearance.

Metering Three-Phase Power—I have a 75-hp. 220-volt three-phase 60-cycle motor and wish to install integrating wattmeters. As the meters on hand were rated at only 150 amperes, I put two of them in parallel on one phase, as shown in the figure. With this connection the meters ran very slowly when the motor was loaded; when the load was light the meters ran backward. What caused this action of the meters? C. S. H.

The action of the meters was due to their being connected in the low-reading side of the circuit. If a watt-hour meter is connected first in one phase of a three-phase circuit and then in another phase, it will be found that the readings will not be alike unless the load is balanced and the power factor 100 per cent. When the power factor is less than 100 per cent., even if the load is balanced, as it generally is in the case of an induction motor, the meter will read higher on one phase than it does on the other as



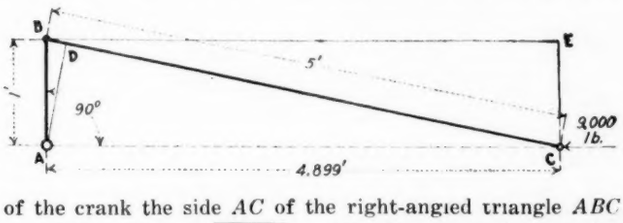
long as the power factor is greater than 0.50. When the power factor is less than 0.50, if the meter is connected to one phase it will read fast and will reverse when connected to the opposite phase. This is what happened as the meters were connected in on the low reading phase. When the motor was loaded, the power factor was above 0.50 and the meters registered slowly in the proper direction, but when the load was removed from the motor the power factor dropped below 0.50 and the meters reversed and ran in the opposite direction, as they should. If the meters had been connected into the opposite phase, they would have run fast and indicated an excess load on the motor. The only way that three-phase power can be metered satisfactorily is with two single-phase meters connected into two of the phases, or with a polyphase meter, which is practically nothing more than two single-phase meters combined in one instrument.

Effect of Moisture on Engine Economy—What effect has moisture of steam on economy of an engine? An engine that is guaranteed to develop a horsepower-hour on 28 lb. of dry steam is found to require 30.8 lb. of steam containing 5½ per cent. of moisture. What per cent. is the performance above or below the guarantee? R. N. L.

Experiments on engine economies, using steam of various percentages of dryness, seem to confirm the fact that the ill effect of moisture is proportional to the percentage of moisture present; that is, the consumption of dry steam remains practically constant. Accordingly, a consumption of 30.8 lb. of steam containing 5½ per cent. moisture would be equivalent to consumption of $30.8 \times (1 - 0.055) = 29.1$ lb. of dry steam, and if 28 lb. of dry steam was guaranteed, it is fair to assume that the steam consumption is $(29.1 - 28) \div 28 = 0.039$ or practically 4 per cent. greater than guaranteed.

Pressure on Crankpin and Guide—An engine crankshaft that is 1 ft. long is placed at right angles to the line of the engine and blocked there. The length of the connecting-rod is 5 ft. and there is a force of 9000 lb. acting on the piston. Neglecting friction, what is the pressure on the crankpin and what is the downward pressure on the guide? J. V. M.

Referring to the diagram, if AC is the engine center line, AB the crank 1 ft. long at right angles with AC, and BC the connecting-rod 5 ft. long, then for the given position



of the crank the side AC of the right-angled triangle ABC would be equal to $\sqrt{5^2 - 1} = 4.899$ ft. From A draw AD perpendicular to BC. In the right-angled triangle ADC, if AC by its direction and length is taken to represent the force of 9000 lb. acting from C toward A, then DC will represent the direction of pressure exerted on the crankpin due to the thrust of the connecting-rod from C toward D, and to the same scale that the length of the side AC is taken to represent the pressure 9000 lb. acting along the center line of the engine. As the right-angled triangles ABC and ADC are similar, $DC : AC :: AC : BC$, or as 4.899 : 5, and therefore the pressure on the crankpin, represented by DC, is $\frac{4.899}{5}$ of 9000 lb. = 8818.2 lb.

To find the pressure down on the guide, suppose BC to represent the direction and magnitude (8818.2 lb.) of thrust of the connecting-rod. This force, acting from C *to* B, can be resolved into two others at right angles to each other; namely, EC perpendicular to AC representing the direction of pressure exerted on the guide, and BE the force exerted by the thrust in the direction parallel to AC. The triangle BEC is equal to the triangle ABC and $EC = AB = 1$. As the thrust of the connecting-rod, amounting to 8818.2 lb., is represented to the same scale by $BC = 5$, then EC, which represents the pressure on the guide, has a value of one-fifth of 8818.2 lb. = 1763.6 lb.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Economy of Arizona Power Plants Using Oil Fuel*

By C. R. WEYMOUTH
Chief Engineer, Charles C. Moore & Co., San Francisco, Calif.

Treats of the performances of three steam-electric power plants in Arizona where load factor and high fuel cost demand economical operation. Tables and curves of operating characteristics are given and some of the difficulties encountered in practice are enumerated.

IN certain Arizona steam power plants the combination of favorable load factor and high fuel cost has not only necessitated but has also made possible the attainment of high fuel economy, and even in plants where cooling ponds are used for condensing purposes. This paper refers to the performance of three such power plants; namely, those of the Inspiration Consolidated Copper Company, Inspiration, Ariz.; the New Cornelia Copper Company, Ajo, Ariz.; and the Arizona Power Company, Clarkdale, Ariz. These plants

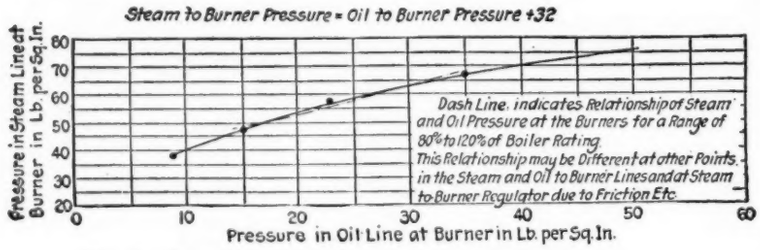

Steam to Burner Pressure = Oil to Burner Pressure +32
Pressure in Steam Line at Burner in Lb. per Sq. In.
Pressure in Oil Line at Burner in Lb. per Sq. In.
Dash Line indicates Relationship of Steam and Oil Pressure at the Burners for a Range of 80% to 120% of Boiler Rating. This Relationship may be Different at other Points in the Steam and Oil to Burner Lines and at Steam to Burner Regulator due to Friction Etc.

FIG. 1 STEAM AND OIL PRESSURES AT BURNER LINES

embody many similar features. They differ, however, in methods of condensing as cooling ponds are used at the Inspiration and New Cornelia plants, and water from the Verde River at the Arizona Power Company's plant.

The Inspiration plant was designed in the winter of 1913-14. The International Smelting and Refining Co.'s smelter adjoins the Inspiration power-plant site, and the steam generated in waste-heat boilers in the smelters is utilized for the operation of the reciprocating blowing engines, which are designed for about 175 lb. steam pressure. These blowing engines are located in the same power-plant building as the steam turbines, and since the waste-heat boilers are connected to the same steam header as the oil-fired boilers, their steam pressure and the economy of the turbine plant have been limited by the common steam pressure of from 175 to 185 lb. The New Cornelia Copper Co.'s plant was designed in the winter of 1915-16, and being independent of blowing engines, the boilers were selected for 250 lb. pressure. While a higher steam pressure would have been possible, the remote location of the plant and experience at the date of design led to the lower boiler pressure being selected. The Arizona Power Co.'s plant was designed in the winter of 1916-17, and has boilers for 250 lb. pressure.

The Inspiration plant is 25-cycle, 3-phase, 6500 volts. The New Cornelia plant and the Arizona Power Co.'s plant are both 60-cycle, 3-phase, 2300 volts. The maximum load at the Inspiration plant was estimated to be 12,000 kw.; three 6000-kw. Curtis turbines were therefore selected, thus giving one spare turbine. For the New Cornelia plant the load was estimated to be 7500 kw., and this led to the selection of two 7500-kw. turbines, one unit being a spare. The Arizona Power Co.'s plant was designed as an auxiliary to a hydro-electric system, and intended to carry a peak load of 5000 kw. Owing to the quick shipment required, however, a turbine previously ordered for another company, and rated at 6000 kw., was installed, whereas the remaining equipment was selected for a 5000-kw. load.

All three plants have Stirling steel-encased boilers, with Peabody-Hammel oil furnaces, Green fuel economizers, Moore automatic fuel-oil regulating systems, Wheeler surface condensers, Wheeler dry vacuum pumps, centrifugal hotwell pumps, direct-connected exciters, steam-driven boiler-feed pumps, etc. Superheaters are installed in all plants, specified to give 100 deg. superheat for the Inspiration plant, and 150 deg. superheat for both the New Cornelia and the Arizona Power Company's plants, all measured at the boiler, and at normal rated capacity of the boilers. All the plants also have centrifugal circulating pumps, the Inspiration pumps being turbine-driven, and the others motor-driven.

The nozzles for the cooling pond of the Inspiration Copper Company's plant were furnished by one of the spray pond companies, who also proportioned and designed the pond arrangement. The actual vacuum shown by the operation of this plant, however, has been a disappointment, as a pond of insufficient area was installed. Since the design of the Inspiration plant this detail has been corrected by the addition of cooling towers. The condensate is returned to the oil-fired boilers, and make-up water for the pond is purified by a Booth water softener. A Cochrane hot-process purifier purifies the make-up for the oil-fired boilers if needed, but it is primarily for purifying boiler feed for the waste-heat boilers installed at the smelter. The blowing engines operate at slightly lower vacuum than the turbines, and advantage is taken of this fact to heat slightly the turbine condensate by passing it through the Volz heaters in the surface condensers or the blowing engines.

Cole-Bergman water weighers and Lea recorders are installed for feed-water measurements, for computing the steam supplied from the waste-heat boilers and the steam required by blowing engines, as well as the steam consumption of the turbines. Steam-flow meters are also used for checking purposes. By this means a separate record is kept of the economy of the turbine plant on the basis of operation independent of the blowing engines.

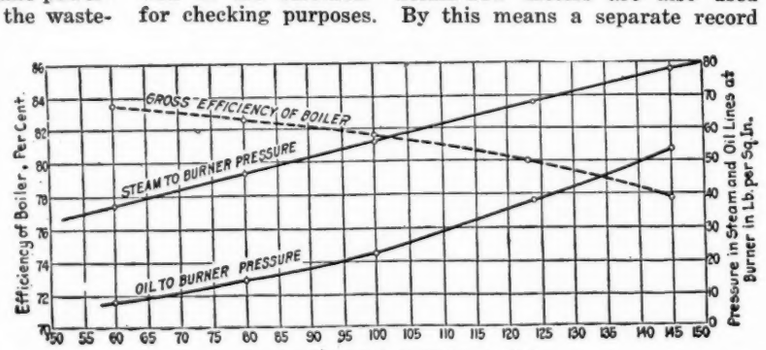

GROSS EFFICIENCY OF BOILER
STEAM TO BURNER PRESSURE
OIL TO BURNER PRESSURE
Efficiency of Boiler, Per Cent.
Pressure in Steam and Oil Lines at Burner in Lb. per Sq. In.
Per Cent of Rated Capacity of Boiler

FIG. 2. PRESSURES AND EFFICIENCIES AT VARIOUS LOADS

The feed water for the New Cornelia plant contains from 30 to 50 grains of impurities per U. S. gallon. The water is low in calcium sulphate and carbonate, high in sodium sulphate, and very high in sodium chloride. It is not practicable to purify this water by chemical treatment. The condensate from the condensers is returned to the boilers, and raw make-up water is used for the pond and boiler-feed make-up purposes. Frequent blowing down is required for the cooling pond, as well as for the boilers. Scale is also

*Presented at the Spring Meeting, Detroit, Mich., of The American Society of Mechanical Engineers.

formed both in the condensers and the boilers, and this requires frequent cleaning, as condenser scale tends to impair the vacuum.

The Arizona Power Co. uses Verde River water for condensing purposes, this being taken through a flume at such a point that the pumping head is reduced by gravity flow. The condensate is returned to the boilers, and the raw make-up water is purified in a Cochrane hot-process purifier.

Economy of Inspiration Consolidated Copper Company Plant—Upon the completion of the Inspiration plant it was placed in regular service. The performance of the individual pieces of apparatus was investigated in order to make certain that everything was working to the best advantage, particular attention being paid to the efficiency of boilers, the adjustment of burners, furnaces, and the automatic firing system. A number of uniform load tests were made of boilers for checking purposes, and the results obtained are given in the curves of Figs. 1 and 2. These tests show a fairly high efficiency at rating, and, rather contrary to the usual results obtained with noncasing boilers, a higher efficiency at fractional loads than at rating. The higher efficiency is due to the tightness and the insulating efficiency of the steel casing. As a result of these tests, instructions were given the operators to divide the load equally among all boilers and this, of course, was done automatically by the firing systems. The operators, however, were instructed to keep as many boilers on the line at light loads as could be properly fired, maintaining a fire in each of the three burners per boiler; below this load boilers were cut off the line, and only refired when the load again increased.

The curves of Figs. 1 and 2 show the relation between the steam pressure of the atomizing steam and the oil pressure, both measured in the supply pipes at the individual burner, between the throttle valve and burner. From data obtained from these curves, the steam-to-burner regulator was set to give the proper pressure of atomizing steam, based on the momentary oil pressure.

Under variable load the damper controller has been able to maintain CO_2 readings varying from 12 per cent to 14.5 per cent CO_2 for which the corresponding excess air for normal conditions is 28 per cent and 6 per cent, respectively. After instructing the operators, and while the plant was still under the control of the engineers, an average economy was obtained for the month of September, 1915, as given in the following table:

Average number of turbine units in operation	1
Average daily load, 24-hr. basis, kw	5,980
Average steam pressure at boilers, lb. per sq.in	178
Average vacuum in condensers, in. of mercury, absolute	2.66
Average rating of boilers, per cent	95
Gross boiler efficiency, per cent	80.9
Average economy, kw.-hr. per bbl. of oil as fired	281
Average economy B.t.u. per kw.-hr.	25,900

In the subsequent operation of this plant by the owners the economy has been maintained practically equal to that shown under the direction of the engineers, but during the winter, due to colder circulating water, the economy is even better than indicated above. On the other hand, during the summer months, with the warmer circulating water and falling off in vacuum, the economy naturally drops to a lower figure than that given for the month of September.

This plant operates in conjunction with the hydroelectric plant at the Roosevelt Dam, and at periods of the year preference is given to hydroelectric power. As a result, there is a fractional load, or partial shutdown of the steam plant, and for certain months this in turn has naturally resulted in a reduced economy.

The operating results for the plant, furnished by W. W. Jourdin, chief engineer of the Inspiration power plant, are given by the curves of Fig. 3. It will be noted that the best monthly economy for winter conditions has been 294.5 kw.-hr. per bbl. of oil, or 20,910 B.t.u. per kw.-hr.; and the poorest economy for summer conditions for the normal load has been 257.5 kw.-hr. per bbl. of oil, or 23,700 B.t.u. per kw.-hr., although for the month of September, 1917, due to the very light load, the economy was only 237 kw.-hr. per bbl. or 25,970 B.t.u. per kw.-hr. As previously stated, this plant, in comparison with non-cooling-pond plants, is subject to an accumulation of scale in the condensers, and as a result there is a slight loss in vacuum. Since purified feedwater is used, the plant is not subject to troubles from scale formation in the oil-fired boilers, nor does any loss of fuel result from shutting down boilers for cleaning or boiler blowoff.

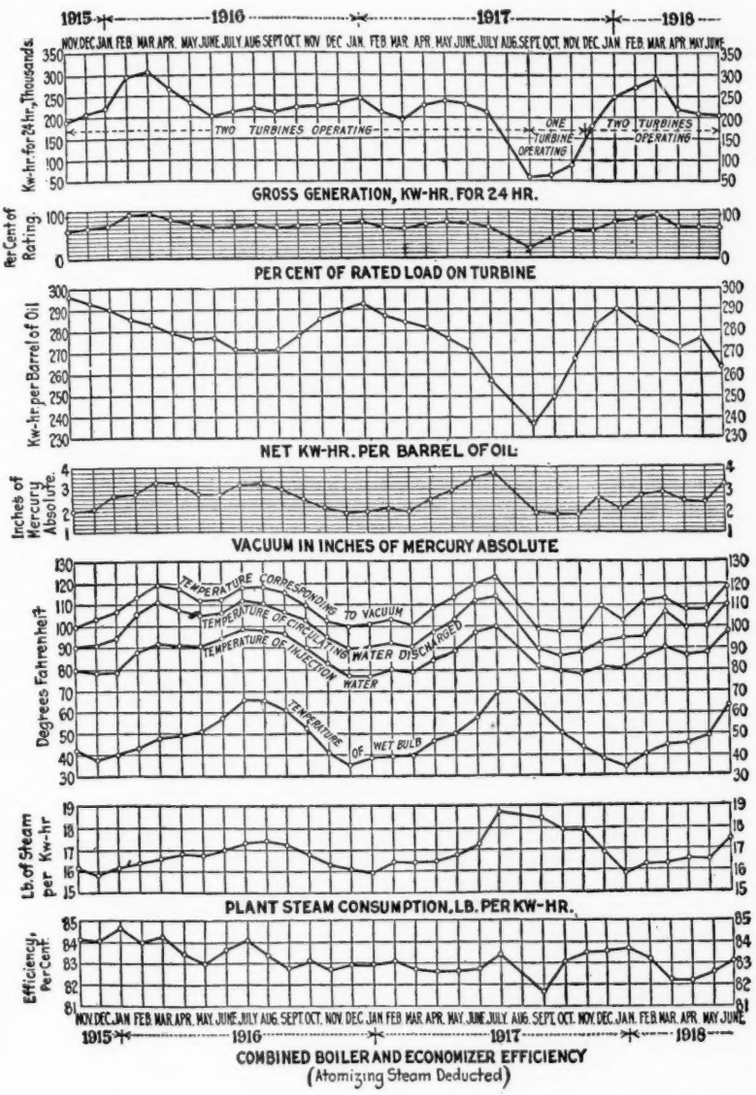

1915
1916
1917
1918
NOV. DEC. JAN. FEB. MAR. APR. MAY. JUNE. JULY. AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY. JUNE. JULY. AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY. JUNE.
Kw.-hr. for 24 hr., Thousands
TWO TURBINES OPERATING
ONE TURBINE OPERATING
TWO TURBINES OPERATING
GROSS GENERATION, KW-HR. FOR 24 HR.
Per Cent of Rating
PER CENT OF RATED LOAD ON TURBINE
Kw-hr. per Barrel of Oil
NET KW-HR. PER BARREL OF OIL
Inches of Mercury Absolute
VACUUM IN INCHES OF MERCURY ABSOLUTE
Degrees Fahrenheit
TEMPERATURE CORRESPONDING TO VACUUM
TEMPERATURE OF CIRCULATING WATER DISCHARGED
TEMPERATURE OF INJECTION WATER
TEMPERATURE OF WET BULB
Lb. of Steam per Kw-hr
PLANT STEAM CONSUMPTION, LB. PER KW-HR.
Efficiency, Per Cent
COMBINED BOILER AND ECONOMIZER EFFICIENCY
(Atomizing Steam Deducted)

FIG. 3 OPERATING CHARACTERISTICS OF THE INSPIRATION POWER PLANT

The curves of Fig. 3 give the operating records for combined boiler and economizer efficiency, atomizing steam deducted; this being the form in which the power-plant records are kept. A comparison of this result with the boiler efficiency tests would seem inconsistent without the explanation that the economizers at this plant heat the feed water through a temperature range of from 40 deg. to 45 deg., whereas it will be noted that results for the Arizona Power Company's economizers, given in the table indicate a temperature rise in the economizer of 91 deg. F. In proportioning the Inspiration economizers with reference to the investment and fuel saving, it was assumed that the average period of operation would be less than half the year, owing to the use of hydroelectric power; it was

also assumed that the fixed charges would be very high. This combination of circumstances, together with high freight rates and construction costs in Arizona, resulted in the selection of an economizer of comparatively small surface, giving a favorable return on the investment but a result considerably less favorable than that attained in the average economizer with oil fuel, when measured only by temperature rise.

Economy of the New Cornelia Copper Company Plant—Following the installation of the New Cornelia plant in November, 1917, an attempt was made by the designing engineers to check the economy of the station, but owing to the war and a scarcity of labor this work had to be abandoned before completion.

This plant, due to its location in the southwestern portion of Arizona, is subject to more intense summer heat than probably any other power plant in the western territory, and this in turn gives rise to considerably less favorable cooling-pond and condenser performance, with respect to vacuum, for the summer months than for the winter months. The vacuum performance is also influenced by the accumlation of scale within the condensers between the periods of cleaning condensers, due to concentration of salts in the cooling pond.

The best economy for this station known to the writer is for the month of January, 1918, the average performance for four successive days being about 324 kw.-hr. per bbl. of oil, as follows:

Date 1918	Average Load, Kw.	Economy, Kw.-hr. per Bbl. of Oil	B.t.u. per Kw.-hr.
January 26	7921	321.7	18,975
January 27	7830	324.1	18,833
January 28	7725	324.2	18,829
January 29	7800	326.2	18,711

The poorest economy for this station during the summer of 1917, was for the month of July, namely, 293.5 kw.-hr. per bbl. The average vacuum was 1.66 in. absolute and the average load 5550 kw. The poorest economy during the summer of 1918 was also for the month of July, or 287.5 kw.-hr. per bbl. The average vacuum was 2.14 in. abs., the average load 5850 kw., and consequently the economy for the summer of 1918 was abnormally low.

The monthly report for December 1918 gives the following: Average load, 7800 kw.; average economy, 312 kw. per bbl. and 19,913 B.t.u. per kw.-hr. The monthly report for January 1919 gives: average load, 7790 kw.; average economy, 317.9 kw. per bbl., and 19,535 B.t.u. per kw.-hr. The improvement for the month of January over December is due to a straightening out of the aforementioned difficulties experienced in the summer of 1918, and it is the writer's belief that the station will soon be operating at its best previous economy for the corresponding season.

It will be noted that the economy of the New Cornelia plant is materially better than that of the Inspiration. This is due somewhat to the larger turbine units installed, but in the main to the higher steam pressure and to the improved design of cooling pond, which results in better vacuum. In comparing the economy of these cooling-pond stations with that obtained in tidewater plants, allowance should be made for the size of turbine units, the obtainable vacua under operating conditions, the increased head on circulating pump due to the greater quantity of water which must be handled through the condensers, and the increased pumping head due to the cooling-pond nozzles and longer lengths of circulating-water line.

Economy of the Arizona Power Company's Plant—This plant was completed in September, 1917, and due to the war conditions in the mining region it was difficult to assemble a skilled operating crew. The plant was furnished under a contract covering a complete plant-economy guarantee at 5000-kw. load, and the final test, covering 48 hours' operation in regular commercial service, under variable load, was concerned mostly with the economy at this load, although a run was made at 6000-kw. load, which is the rated capacity of the turbine. The results for the final test are here given in the table. At all times during this test the plant was subject to a variable load, due to the regulation of the hydroelectric system. The oil was carefully weighed and the electrical output was measured by calibrated meters. The electrical output given is the net useful output for the station at the 2300-volt bus, deduction having been made for the power consumption of electric auxiliaries, including lighting for the operators' cottages, circulating water pump, deep-well pump and air washer. The average electrical auxiliary load was 46 kw., which is somewhat smaller than would have been the case had the entire head on the circulating water been overcome by pumping; against this condition is the fact that during the test the quantity of circulating water was somewhat less than specified, so that, roughly speaking, the one condition nearly offsets the other.

It is not possible to give daily operating results for this plant, at the load for which it was designed, for since its installation it has been maintained only for reserve purposes, carrying occasional peaks but most of the time a very light load, and for a number of hours during an average day with the turbine at standstill. Of course favorable economy is not possible under such conditions, as the fuel losses due to keeping hot boilers, piping, etc., the dead-load losses for the operation of auxiliaries, and the zero-load steam consumption of turbine result in a zero-load fuel consumption of the plant which is an appreciable percentage of the full-load fuel consumption.

It is of interest to note that the turbine at the Arizona Power Company's plant is practically a duplicate of those at the Inspiration Copper Company's plant, having the same number of stages; the difference in the operating economy of the turbines being largely due to steam pressure. Here again is a marked increase in plant economy due to an increase in steam pressure, and also by reason of the colder river water at the Arizona Power Co.'s plant as compared with the cooling-pond water at the Inspiration plant and the consequent improvement in vacuum. All economy figures are based on oil as fired, without deduction or correction for moisture, sulphur, or silt.

RESULTS OF TEST OF THE ARIZONA POWER COMPANY'S STEAM PLANT AT TAPCO, ARIZ.

Duration of test, hours	6
Boiler pressure, lb. per sq.in., gage	250
Steam pressure at turbine throttle, lb. per sq.in., gage	238.5
Avg. temp. of superheated steam at boilers, deg. fahr.	546
Temp. of superheated steam at turbine, deg. fahr.	516
Temp. of feedwater entering boilers, deg. fahr.	207
Temp. of water leaving feedwater heater, deg. fahr.	116
Temp. of circulating water from condenser, deg. fahr.	62.4
Temp. of circulating water to condenser, deg. fahr.	45.7
Room temperature, deg. fahr.	83.2
Barometer, inches of mercury	26.773
Vacuum in condenser, inches of mercury	25.783
Absolute vacuum, inches of mercury	0.990
Temp. of flue gases leaving economizer No. 3, deg. fahr.	276
Average load, kw. per hr.	5,815
Power factor by power-plant indicator	0.93
Electrical Output by Integrating Meters:	
Gross kw. generated	34,890
Gross kw.-hr.	5,815
Auxiliary power, kw.	277
Net kw. output	34,613
Net kw.-hr. output	5,769
Oil Measurements:	
Total oil weighed, lb.	34,516
Correction due to diff. in temp. at start and finish, lb.	46
Oil actually used, lb.	34,470
Average gravity of oil (analyzed by Smith, Emery & Co.), deg. B.	17.65
Weight of oil per bbl. of 42 gal.	332
Heat value of oil (analyzed by Smith, Emery & Co.), B.t.u. per lb.	18,703
Economy:	
Fuel used per gross kw.-hr., lb.	0.988
Fuel used per net kw.-hr., lb.	0.996
Kw.-hr. per bbl. of oil, gross	336.0
Kw.-hr. per bbl. of oil net	333.3
B.t.u. per kw.-hr., gross	18,478
B.t.u. per kw.-hr. net	18,628

Petroleum Institute

The establishment of a petroleum institute for this country with headquarters in Washington is urged and contemplated by many of the leading petroleum refiners. The rapidly diminishing stocks of petroleum oils in this country have been causing much concern among oil refiners, and problems growing out of the increasing demands for oil products promise to assume alarming proportions in the next few years. The proposed institute will afford a means of coöperation between the Government and all the branches of the oil industry.

Mechanical Engineers Hold Spring Meeting in Detroit

FOR the four days from June 16 to 19 inclusive, in the ideal convention city, Detroit, the American Society of Mechanical Engineers held one of the most profitable and enjoyable meetings in the history of the organization. The attendance was the largest on record for a spring meeting. Topics of foremost importance to the profession were up for consideration. The report of the Committee on Aims and Organization was representative of the progressive thought of the day and gave promise of remarkable engineering advancement. There was a session on research considered the key to industrial progress, discussion of industrial relations under present conditions and sessions on fuel economy and furnace efficiency, gas power and other topics of engineering interest. All was not work, however, as professional sessions alternated with inspection trips to the numerous industrial plants that have made Detroit world famous. Then there was entertainment. No city in the country has more or better facilities on land and water or hospitality to use them to the fullest extent in the entertainment of guests, than Detroit. The local committee is to be congratulated as it was the consensus of opinion that the arrangements for an enjoyable time, renewal of acquaintances and interchange of ideas were perfect.

Monday Morning and Afternoon Sessions

Monday morning was devoted to the opening of headquarters and registration at Hotel Statler. In the afternoon there was a business meeting with President Cooly in the chair, to hear read by title the reports of the Boiler Code Committee on rules for the construction of boilers for locomotives, the reports of subcommittees on flow meters, bearing metals and lubrication and the epoch-making report of the Committee on Aims and Organization. The report was given as a cross-section of the opinion of the membership gathered from the questionnaires that had been sent out. The committee considered it a constructive program expressed in broad principles to meet the real problems with which the society is now confronted. The report was not considered complete, as the committee is to meet with a joint committee of the four founder societies to give it further consideration. An expression of opinion from the convention as a guide to the council and the committee was requested, and the various resolutions were passed upon singly or in groups.

Among these resolutions it was the sense of the meeting that the society should stand back of professional reports and standards by adopting them rather than pursuing the present passive policy of accepting the reports. It was suggested that such procedure would necessitate members, from the standpoint of loyalty, following the standards set and would eliminate freedom in a choice of methods. Another resolution was to discontinue standing committees, to prepare a list of topics and appoint committees specially qualified for the specific work. Memberships were to expire automatically at the end of the term, but in reconstituting the committee a sufficient number of experienced members should be selected to insure continuity of policy. In this way members who would not work or who were not well qualified would be eradicated.

Research and Standardization

Under research and standardization it was resolved that the society take a more active interest in research by increasing the appropriations from its own funds and by securing funds from other sources, by determining and formulating problems requiring investigation and securing men and facilities to solve them. Standards adopted were to be limited to elements, and standardization of combinations was to be left to organizations devoted to special industries. All standards were to be considered as progressive and not ultimate.

Industrial engineering was considered as a major subject for consideration by the society, and it was the sense of the meeting it should be placed on a par with technical subjects.

The committee approved the work now being done in student branches, but recommended that it be strengthened and that a committee be appointed to look after the interests of the society in industrial education below the grade of college work. There was a field for membership among trained subordinates of engineers and industrial workers.

Owing to requests for the formation of ordnance, power plant, automotive and petroleum sections it was recommended that a standing committee on professional sections be constituted, analogous to that on local sections.

A resolution proposing to make *Mechanical Engineering*, the official organ of the society, a weekly publication received severe criticism and was rejected. It was considered that the expense of issuing the journal four times per month instead of once would form such a large proportion of the income of the society that publishing the paper would become the major work of the society rather than the interests of the members and the advancement of the profession. It would be placing the tail ahead of the dog. Although the monthly was on a paying basis, due to the loyalty of the advertiser rather than a consideration of the returns, there was no assurance that a weekly without advertising solicitors would do equally well. The paper as now printed was giving excellent service, was highly regarded and should be allowed to progress as it had been doing steadily for some time.

Proposed Handbook of Mechanical-Engineering Data

The Committee on Publications and Papers was requested to study the possibility of a substitute for the present expensive method of publishing the transactions and present the plan developed at the annual meeting. As soon as practicable it was proposed that the society publish a handbook of mechanical-engineering data to consist of standards and data of the society and not to conflict with the handbooks already in print.

It was recommended that membership on any council or committee of the society should terminate automatically on account of absence or neglect either willful or due to force of circumstances. Another resolution was to the effect that the joint employment bureau in New York be retained and its activities be expanded and made more efficient; also that the names of employment officials be secured especially through the local sections and that these officials be supplied with lists of men.

It was the sense of the meeting that the present code of ethics was unenforceable for the reason that it had no "teeth." There was a resolution to refer the code to a committee of ethics to be appointed by the president and confirmed by the council.

Following were a series of resolutions to the effect that the council of the society should actively encourage further development of coöperation both in local organization under the leadership of local engineering societies and in state or territorial groups, which can effectively handle state or territorial problems, this coöperation to take such form as will most readily lend itself to national coöperation.

The next step recommended was the creation of an agency of national character through which the coöperation of local groups, state groups and national societies can be secured for the purpose of national scope, the agency to be composed of representatives of the members of the various groups already mentioned and capable of speaking in the name of the profession. Various modes of coöperative organizations were to be collected and published by the society in pamphlet form for the guidance of the various groups or organizations contemplating coöperation.

Acting through the organization previously suggested, service to the community may best be promulgated by securing legislation for the protection of health, life and comfort, the introduction of safety codes, enforcement of smoke prevention ordinances; establishment of standards of size, strength and quality of manufactured products; initiating and guiding legislation for the operation, development and conservation of industries, utilities and national resources owned or controlled by committees; action to secure uniform state and Federal laws for the registration and certification of professional engineers whose work involves public health, safety and well being; the placing of engineers in public positions requiring engineering training, coöperation with and support of engineers in public places, selection of engineers to meet public emergencies, action in conjunction with civic bodies to enforce law, by an active program of education in the press to broaden the public knowledge of and appreciation for engineering achievements. Distinctly technical work was to be done by those technical societies jointly or severally concerned with the particular subject in question.

To the foregoing some objection arose, and Mr. Dow, of the Detroit Edison Co., introduced a resolution to replace those outlined with the idea of avoiding what he considered some of the controversial features in the report of the committee. A lengthy discussion ensued, but the resolution was lost by a narrow vote and the committee resolutions with slight modifications were approved.

As the engineer must devise industrial methods that will insure greater and more efficient production and more equitable distribution of it, he must take the lead in their adoption and often finds himself between opposing interests—an obdurate employer on one hand and the radical laborite on the other. Industry remains to be democratized, and in the process there will be many questions which the engineer should discuss and on which he should be thoroughly posted. With these ideas in view it was the sense of the meeting that the society should enlighten its members on all Federal, state and local problems which should interest engineers and in the solution of which their experience and training may be helpful.

Nominating Committee

A resolution meeting with considerable objection specified that the nominating committee for the election of officers be composed of a member from each local section, provided that each voting member be assigned to some local section by the Committee on Local Sections exclusively for electing a nominating committee member, that members of the nominating committee be elected annually for one year and that no member shall be eligible for more than two consecutive terms. It was proposed to embody the foregoing resolution in the constitution, but it was the sense of the meeting that it might better be incorporated in the bylaws or rules. The procedure for the annual election of officers was to be changed to permit earlier declaration of their election, probably at the spring meeting, and that biographical sketches of all candidates for office should be sent out with the ballot for election.

After all resolutions had been considered, Mr. Marburg, of the committee, introduced several formal resolutions amending the constitution so that the various recommendations favored might be carried into effect.

Professor Greene introduced an amendment to the constitution making the Research Committee a standing committee of administration, which would give its chairman a seat on the council, whereupon Mr. Marburg introduced an amendment to the constitution giving to the chairmen of all standing committees a seat on the council without vote.

On Tuesday there were research sessions lasting throughout the day. Arthur M. Greene, Jr., chairman of the Research Committee, conducted the meetings, and in this capacity naturally presented the first paper, which dealt with the conditions under which research is now being carried on in this country.

The author discussed research in technical schools, giving a list of universities having mechanical-engineering laboratories and research in engineering-experiment stations, with a list of stations and of those publishing bulletins. Coöperative research, activities of the Government and finally commercial and industrial research work including lists of private research laboratories in the country and manufacturing companies having their own research facilities, were considered. Research was considered the keystone of commercial success in this country, in contradistinction to the former hit-or-miss methods. The paper was intended to outline and bring together the numerous research agencies of the country. A number of slides showing various laboratories were presented.

War Work of National Academy of Sciences

Dr. Clevenger spoke of the National Academy of Sciences and its able work following the Civil War, the organization of the National Research Council during the World War and its perpetuation in times of peace to stimulate and organize research.

The speaker outlined the present organization, covering the entire range of science and in particular the division of engineering, consisting in all of 28 members, three from each of the four founder societies, one from each of four important nonfounder societies and twelve members at large. The division was in full coöperation with the Engineering Foundation. It was the stimulator and coördinator of research, and its aim was to get more and better research work done. The work was being carried on by committees made up of leading men in educational institutions, Government bureaus and other sources. The council was not a Government bureau and must receive support from private endowment.

Dr. Mees, from the Eastman Kodak laboratories, told how a laboratory should be organized, outlined the conduct of the work and emphasized the importance of giving publicity to the results obtained. He was not in favor of research work paid for by the Government. Those requiring it would appreciate the work more by paying for it and they would gladly do so as it was a paying investment. On this account the speaker had no concern over applied research, but feared that pure scientific research, or the fundamental things that did not appear to pay, might be neglected. He was heartily in sympathy with the campaign to be conducted by the National Research Council on the necessity of pure research, and it was his plea that it be given the utmost consideration.

A paper by Enrique Touceda gave an interesting account of four years of research work on malleable-iron castings undertaken for the American Malleable Castings Association, which resulted in greatly improving the product of the members and in dispelling many fallacious ideas and theories regarding the physical properties of these castings and the methods of annealing them. The paper offered a striking example of what industrial research among manufacturers can accomplish.

Organization and Conduct of Industrial Laboratory

Dr. H. E. Howe, now with the National Research Council, presented a paper which had been prepared in conjunction with A. D. Little on the "Organization and Conduct of an Industrial Laboratory." The aims of a research organization were outlined, divisions of the laboratory enumerated, methods of management, writing of reports, etc., discussed, with a description of the building and equipment best suited to carry out this type of work. Following were talks by various directors of state engineering-experiment stations, private and other laboratories, outlining the equipment and the character of the work being done in each. All were desirous of increasing the scope and usefulness of their work to the industries and of developing closer coöperation between the laboratory and the interests they concern.

Near the close of the session J. R. Bibbins presented a resolution containing six elements expressing the ideas of the Chicago section of the society on the duties of the research committee. In effect the resolutions follow: First that the Engineering Council should be encouraged to secure passage of a Congressional bill properly worked out for Federal support of general research in state units. Each state had its own problems which it could best care

for. Second, encourage research and advancement of the arts among trade, industrial and utility associations. Third, encourage all research institutions now operating or to be established by the Federal and state governments to coöperate with the society in this general research policy. Fourth, assist in the establishment and proper equipment of experiment-station research laboratories at the various state universities and help to bring them as closely as possible in touch with vital problems. Fifth, canvass the needs of the industries and direct research work on the coöperative plan, utilizing all available laboratories, both public and private. Sixth, organize and support a separate department of the society's activities in close coöperation with similar departments of other technical societies, to act through the Engineering Council or other representative national agency as a permanent clearing house for all research work.

There was some objection to a national bill, as it was felt that the Research section should not put itself on record as favoring national support, private paying for research being preferable; secondly, that the section should favor every form of research and not any particular method. It was explained by Mr. Bibbins that the formulators of the resolutions were fighting for recognition of the advantages of research among the industries. The object was to assist each state to the maximum possible development of its own resources through a properly organized clearing house, with Government support as far as possible and in addition utilizing every agency. Their slogan was "Millions for Agriculture. Not One Cent for Industry. Why?" The resolutions were favored verbatim.

Industrial Relations Session

On Tuesday afternoon there was a most interesting and prolonged session on industrial relations.

Arthur H. Young, of the International Harvester Co., in his paper, "Industrial Personal Relations," predicted a new epochal era in industry due to the focusing of attention on industrial personal problems. He reviewed the industrial safety-first movements, originating in the Illinois Steel Co. Works at South Chicago; the resulting decrease in accidental deaths and permanent disabilities, and the byproduct results of reduced labor turnover and increased morale of the labor force. The accidental deaths up to 1906, the year the safety movement was started, averaged 47 per year. This number has been cut down to the present low figure of 6 or 7 per year and the results are typical of those in other plants where similar movements have been started.

Started as a purely humanitarian movement, it was found to be good business also. A profit of approximately 100 per cent. has been shown on the investment in educational films, lectures, safety devices and first-aid equipment by the reduction in cost of labor turnover.

The gratifying results secured by this safety movement lead to "employment management." Men were selected for positions on physical and mental qualifications; they were carefully instructed as to their duties and the hazards, if any, of their particular work; and finally they were personally conducted to their place of work and introduced to their immediate superior and a few of their fellow employees.

Still further improvement in labor costs and morale being noted, the conclusion was drawn that intelligent treatment of and consultation with employees might result in progress in other directions. Shorter hours and higher wages need not mean reduced output and increased costs. On this theory, the International Harvester Co., in March of this year, offered to the employees its now widely known "Works Council Plan."

Briefly, this plan provides for a works council for each plant, to which is submitted all questions of working conditions, wages, hours, etc. Half of the membership of this council is elected by the workers by secret ballot and half is composed of plant executives.

The plan was adopted in 19 out of the 20 plants operated by the company. One of the first, and expected, results of putting the plan into force was a request from all plants for shorter hours and higher wages. But after the management's side of the question had been fully and frankly shown, all these requests were voluntarily withdrawn. In the single remaining case the request was granted.

Mr. Young feels that the plan has been productive of much good both for the employees and the company, and while he does not hold it up as a panacea he feels that a long stride forward has been made in solving the complex problem of bringing capital and labor to a better state of mutual understanding and coöperation.

On the status of industrial relations, L. P. Alford, chief of staff of *Industrial Management*, gave a historical summary of the progressive stages in the development of industrial relations since the period immediately following the Civil War and reviewed the new aspects of the problem developing as an aftermath of the World War now ending.

Discussion of Industrial Relations Papers

Among those discussing the two papers, R. P. Geier, Cincinnati Milling Co., brought out the point that the physician could and should play an important rôle in industrial development by concerning himself with industrial medicine. The community concerns itself with public health, sanitation, housing, recreation, etc. Industry, having developed into the large units of the present day, should equally concern itself with the physical, moral and social conditions of its membership.

Fred. J. Miller told of his personal experiences with collective bargaining and gave organized labor a boost for its constructive fair-mindedness.

Boyd Fisher related how capital and labor are striving to get together to achieve greater production in the service of mankind.

Jacob Spitzglass asked of Mr. Young the pertinent question: Why is it that although the International Harvester Co.'s plan seems to conform with five of the six major lines of development as laid down in Mr. Alford's paper, it does not meet the first and, possibly, most important one of profit-sharing?

Mr. Young's reply was that profit-sharing did not seem to rank as high in the thoughts and aims of labor as many employers seemed to think. Personally, he thought that profit-sharing among officers was a sound principle as they could largely affect profits by wise buying, intelligent planning, skillful dispatching, etc. He further said there actually was a form of profit-sharing in the International Harvester Co., but it was based on the principle of thrift. Employees are permitted to buy stock at an advantageous price and under favorable terms of payment.

S. H. Libby, managing engineer, hoist department, Sprague Electric Works, told of the success of the plan in force at his plant, being similar to that of the International Harvester Co. Since December last, the committee on wages and working conditions has brought up only 14 cases for settlement.

Sections Session, Wednesday Morning

At the Sections Session Wednesday morning, under the auspices of the sections of the Mid-West, J. H. Walker, in a paper on "Central Station Heating in Detroit," discussed the general problem of utilizing the heat ordinarily carried away in the condensing water of an electric generating station. Although it was equivalent to about 60 per cent. of the total fuel burned, complete utilization in heating buildings was impossible owing to the great diversity in the rate of use of the two commodities—electric current and exhaust steam for heating. Distance of the large condensing stations from the business center, high cost of current generation in heating plants due to the low load factor, extra labor, small units, the investment charges and the need of larger pipes to conduct exhaust steam were the chief factors influencing the Detroit Edison Co. in using live steam to supply the central heating load. The author described briefly the four boiler plants employed, which contain 17,470 rated boiler horsepower and in 1918 supplied nearly two million pounds of steam to a distribution system serving 2,700,000 sq.ft. of radiation. The distribu-

tion system contains about twenty miles of underground mains and two miles of tunnels. Consumers' installations and meters were given attention and special mention was made of transmitting steam through feeders at velocities reaching at times 75,000 ft. per min. and with large pressure drops. No objectionable features had been experienced in connection with the high velocities. Where connection was made to the distributing mains, the diameter of the pipe was gradually increased by special taper fittings to reconvert a portion of the velocity into static pressure. In the mains a considerable pressure gradient was also maintained, but was limited by the safe working pressure of the older piping.

As to load characteristics the monthly sales of steam were closely proportional to the differences between 70 deg. F. and the outside temperature. The annual load factor was about 35 per cent.

Other Papers of the Session

Other papers of the session were: "Production of Liberty Motor Parts at the Ford Plant," by W. F. Verner; "Fire Engines and the Essentials of Fire Fighting," by C. H. Fox; and "Electrical Method for Measuring the Flow of Fluids in Pipes," by J. M. Spitzglass. The paper last named gave the theory and the practical development of a meter now in common use employing an electric current measured by an ammeter and watt-hour meter. The current is so regulated by resistance thrown in the circuit by the differential pressure of the flow transmitted through a mercury column that the indications on the meters represent the amount of fluid passing through the pipe. According to the author, practical difficulties had been eliminated and the result was an accurate, reliable instrument.

There was considerable discussion of this paper. In written discussion Professor Gebhardt expressed the opinion that a variation of voltage in the line might interfere with the accuracy of the instrument. By Mr. Dodge, of the General Electric Co., objection was made to the statement in the paper that the mercury was free to rise to seek its own level, as the instrument had no floats, and that the electrical integration was more accurate than mechanical integration. Mr. Bailey brought up the point that by the use of electric current and a quantity of oil there are two more factors to deal with. Mr. Spitzglass explained that it is the mercury itself that comes to the level, whereas with the float mechanism it is the float. Although electricity and oil were introduced, the facts that the meter has no moving parts and that electrical instruments are far advanced, were worth considering. Owing to the differential pressure causing the oil to move one way or the other, and produce an unbalanced column, the size of the oil chamber as compared to the mercury chamber is about 80 to 1, so that with a maximum mercury deflection the error introduced would be about 0.01 of 1 per cent.

Doings of the Gas Power Session

At the Gas Power Session held simultaneously there were three papers. The first, on "Crude Oil Motors vs. Steam Engines in Marine Practice," by J. W. Morton, gave the various factors to be considered in choosing a form of motive power for war vessels and cargo ships and compared the high- and low-powered oil motors of constant-pressure and constant-volume type with the steam engine. The relative advantages of four-stroke and two-stroke cycle engines and details of operation such as piston cooling, lubricating systems, scavenging pumps, etc., were compared.

D. L. Arnold, in a short paper, suggested a simple horsepower formula for the oil engine. There is a wide variation in ratings and numerous formulas that do not give the same results. By comparing the ratings of 115 engines manufactured by 61 companies the author found that 75 per cent. of them used less than 13,000 cu.in. per brake horsepower. To be conservative, he suggested that this figure be adopted as the equivalent of a brake horsepower. The paper contained further suggestions on a standard name-plate.

In the discussion there was objection to applying any definite number of cubic inches per horsepower, and cases were cited where engines of the same proportions varied 100 per cent. in horsepower delivered, owing to the design of the cylinder. Because of variations in fuel consumption at different loads, others did not wish to be limited to a stereotyped formula. It was explained that the suggestion of using 13,000 cu.in. per min. as a horsepower was intended principally for tractors, which were handled mostly by farmers who did not understand scientific data.

"Standards of Carburetor Performance," by O. C. Berry, was the final paper of the session. New carburetors are usually tested by comparison with another carburetor of high reputation, and the comparative performance of the engine decides the issue. On the basis that a carburetor should be judged on its ability to perform the functions essential to proper carburetion, the author enumerated these essentials and presented data that it was hoped would help establish some of the standards of performance. The discussion turned to automobile practice and the greater difficulty of testing carburetors in this field.

Thursday Morning Fuel Sessions

Thursday there were two morning sessions, one on fuel and the other a general session. The former was largely attended, the drawing card being two papers on pulverized fuel, in which comparisons had been made with stoker operation and with producer gas as a fuel for openhearth furnaces. N. C. Harrison gave costs of preparation, described the plant at the American Iron and Steel Manufacturing Co., Lebanon, Penn., and discussed the use of pulverized coal in stationary boiler plants, the five determining factors in the successful operation of such a plant being taken up in detail. The results of tests on a 468-hp. boiler were given with a summary on pulverized coal vs. mechanical stokers.

"Pulverized Coal for Stationary Boilers," by F. A. Scheffler and H. G. Barnhurst, was the title of the second paper. The authors compared pulverized fuel and stoker plants with particular reference to reliability, cost, adaptability and efficiency. They were somewhat too optimistic in their conclusions and their comparative figures brought out a wealth of discussion, all of which in connection with the papers will be presented in a later issue of *Power*.

A paper by C. R. Weymouth, chief engineer for Charles C. Moore & Co., dealing with the economy of three Arizona steam-electric power plants using oil fuel, was read by title only. The combination of a favorable load factor and high fuel cost not only necessitated but made possible high fuel economy even in the two plants using cooling ponds for condensing purposes. A net kilowatt-hour was produced on less than one pound of oil, or on 18,600 B.t.u., boiler efficiencies ranged from 80 to 85 per cent. and the net production ran as high as 333 kw.-hr. per barrel of oil. The author gave full data in the paper, showing as well the effect on boiler efficiency of steam and oil pressures at the burner and relating some of the difficulties encountered in practice. Mr. Weymouth's paper will be found on page 30 of this issue.

The General Session, Thursday Morning

At the general session there were five papers scheduled. "Elements of a General Theory of Wing Design" was the title of a paper prepared by Walter C. Durfee. A paper entitled "Air Fans for Driving Electric Generators on Airplanes," by Capt. G. Francis Gray, Lieut. John W. Reed and P. N. Elderkin, described the various types of air fans used for driving the electric generators usually installed on airplanes for radio communication. It had been difficult to design a fan that would turn at constant speed with the varying air pressure set up by the machine in flight. The various ways in which this problem was met and the operating characteristics of each type of fan made an interesting discourse.

In a paper on "Mechanical Lifts Past and Present, and a New Method for Their Balancing," Lieut. J. F. Robbins described at some length the various types of mechanical and hydraulic lifts used in canal locks. Of special interest were the particulars of a new type of lift in which the points of support of two counterbalancing loads were so

interconnected that the movements of the supporting elements were synchronized and it was impossible for them to get out of level. The author told how such a plan might be applied to freight-car lifts, lift bridges and lifts for canal locks and for launching and dry-docking.

A. A. Adler, in a paper on the "Design of Riveted Butt Joints," derived from Schwedler's graphical method simple general equations to determine the pitch in any row and the efficiency in ideal cases. Using commercial dimensions actual joints were calculated and close agreement was found between ideal and calculated efficiencies. Symmetry exists in the various types of joint. From the quadruple-riveted joint single-, double- or triple-riveted joints may be derived by omitting the extra rows of rivets.

In the final paper, "Economical Section of Water Conduit for Power Development," by C. T. Hutchinson, read by title, the author gave a formula for determining the best slope and size of a conduit for supplying water to a hydraulic plant. Construction costs, the value of the power recovered, the rate of returns expected on expenditures made and other data were considered.

During the convention period inspection trips were arranged to the plants of the Burroughs Adding Machine Co., the Anderson Forge and Machine Shop, the Connors Creek Plant of the Detroit Edison Co., the Eagle and Highland Park plants of the Ford Motor Company.

Entertainment was of the character for which Detroit is famous the country over. The program was perfect, and every detail had been arranged to a nicety. The local committee is to be congratulated. On Monday evening there was a reception and dance, with refreshments, at the Hotel Statler. Mayor James Couzens addressed the audience in a few brief words of welcome. Tuesday evening there was a musical entertainment at the Arena Gardens, with dancing, cards and refreshments. The crowning feature was a trip through the St. Clair Flats on the steamer "Britannia" Wednesday afternoon and evening. The weather was ideal, the scenery beautiful, and this in combination with the entertainment, dancing and refreshments offered made a "perfect day." At a short session on the boat Past President Main talked of the visit to France of the commission of engineers from this country and of the character of the conference while in Europe. During the session the choice of officers nominated for next year was announced as follows: President, Fred J. Miller, of New York; vice presidents, Prof. R. H. Fernald, E. C. Jones and Prof. J. R. Allen; managers for three years, D. S. Kimball, E. S. Scott and D. C. Fisher; manager for one year, C. E. Lord; treasurer, W. H. Wiley.

Ohio State N. A. S. E. Convention

The twenty-second annual convention of the Ohio State Association of the N. A. S. E. was held at Youngstown, June 19, 20 and 21, with headquarters at the Hotel Ohio. The attendance was not up to the standard owing to the stress of business and the hot weather, but this was fully offset by the lively interest manifested by the delegates in the business of the convention. There appears to be a strong desire on the part of the members to accord in every motion or resolution for the uplift and advancement not only of the state organization, but the N. A. S. E. in general. Several resolutions for the improvement of the existing state license law were brought forward and acted upon.

The sessions of the delegates were held in the auditorium of the hotel, and on the same floor and in close proximity a large room was conveniently arranged for the mechanical exhibit of the various supply houses. About forty well-known firms in the engineering field occupied booths.

The opening exercises of the convention took place on Thursday morning with W. L. Shawkey, chairman of the local convention committee, presiding. He told the audience that Youngstown was an ideal city for an engineers' convention because of the immense industrial power plants surrounding the city, and other attractive conditions. He hoped the visit would prove pleasant and profitable. The gavel was then handed to State President Louis A. Kroner, who, after a brief acceptance, introduced the several speakers.

The Rev. J. H. Palmer, pastor of the Grace M E. Church, offered up the invocation, after which the chairman introduced Mayor A. W. Craver, who cordially welcomed the convention to Youngstown and handed to the president the keys of the city and expressed the hope that he would not forget to return them in good condition.

State President Kroner told of the high quality of the members of the N. A. S. E. and assured the Mayor that Youngstown would be a better city after the visit of the engineers.

Paul J. Jones, vice president of the Chamber of Commerce, was glad to learn that the fundamental principle of the organization was education. He said that never before was there such urgent need for the development of the natural powers of the country and he urged the members to bend their talents in that direction. John A. Matz, state vice president, ably responded.

Samuel B. Forse, national treasurer, representing National President John McKay brought to the delegates the best wishes of the principal officer. He also said that the *National Engineer* was owned by the members and urged that closer attention be paid to its study by the delegates.

John A. Kerley, past national president, said that the best things in the world came through education. He told of the important part played by the engineers in the late war, and the demand that would be made upon them for higher efficiency in the immediate future.

Educational Advantages of N. A. S. E.

Robert Patterson, state deputy, was forceful in his praise of the quality of the engineer having a membership in the N. A. S. E. They have the advantages of the blackboard exercises in their locals and many a good job is being held by men who owe their merit and high rate of wages to their close attention to the teachings of the association.

The convention then went into executive session, and after the necessary committees were appointed, an adjournment was taken until 2 p.m.

On Thursday evening an entertainment, under the auspices of the engineers, was given in the auditorium of the hotel. The audience enjoyed several numbers given by local talent and Jack Armour, of *Power*. W. L. Shawkey was the master of ceremonies.

On Friday afternoon automobiles were furnished for visits to the many places of interest about the city, ending in an inspection of the immense manufacturing plant of the Youngstown Sheet and Tube Mills, and on Friday evening the A. M. Byers Co. gave a motion picture lecture showing the making of wrought-iron pipe from the ore to the finished product.

At the final session of the convention on Saturday morning the following state officers were elected: Louis A. Kroner, past president; John H. Matz, Cincinnati, president; W. L. Shawkey, Youngstown, vice president; George P. Klasgye, Cleveland, secretary; Thomas S. Garret, Dayton, treasurer; Frank B. Seidel, Tiffin, conductor; P. W. Gray, Ashtabula, doorkeeper; Robert W. Patterson, Akron, state deputy.

Retiring State President Louis A. Kroner was the recipient of a past president's jewel and a cash honorarium.

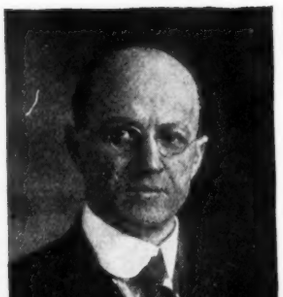
It was decided to hold the next convention at Columbus, in June, 1920.

Canadian Industrial Congress

Western Canada is to have a great industrial congress Aug. 11-16, to which manufacturers and industrial leaders of the continent, as well as those of the United States, are being invited. The discussions are to be made by men foremost in industry and industrial science. Among those who will speak are Sir Robert Borden, Henry Ford, Harold McCormick, E. W. Beatty and Robert Dollar. The congress dates are Aug. 13 and 14, at Calgary, though a trip through the territory including these cities will begin at Medicine Hat Aug. 11, and will conclude at Edmonton, the capital city. All interested in industrial development in the West, or in Western markets, are invited to attend.

Co-operation a Factor in the Solution of Our Economic Problems*

By COMFORT A. ADAMS



COMFORT A. ADAMS

SINCE the last annual convention of this institute the greatest war in the world's history has come to an end. Millions of lives have been sacrificed. Millions of men have been crippled in greater or less degree. Wealth to the extent of many billions of dollars has been destroyed. Most of the nations involved have been seriously impoverished. The whole social, economic and industrial order has received a severe shaking up and has in some countries been completely overturned. Widespread dissatisfaction with the old order prevails in nearly all of the countries involved in the war. Unrest is generally prevalent, and however unreasonable the demands of the restless may seem, there probably is a reason. In any case, "It is a condition, not a theory that confronts us." The old order has failed and can never wholly return. What will be the new order? What are we going to do about it? Are we as engineers, educated men, who pride ourselves on our breadth of vision, who complain because we are not properly recognized in large questions affecting the public welfare, going to crawl back into our little cabins and leave the steering of the ship to those we consider incompetent? Are we going to use our influence to keep the ship on the old course, in spite of the fact that it led to the rocks? Or are we going to ask the same question we ask when our engineering plans result in failure, namely, why? That is, are we going to scrutinize the ship's log to see why she ran on the rocks and then revise the sailing orders accordingly?

These are some of the questions the consideration of which has urged me to deviate somewhat from the custom established by my predecessors, of discussing either institute activities and policies or general engineering questions, in order to present a much broader question, of interest to us not only as engineers but also as citizens—a question that has repeatedly arisen in connection with my work for the institute during the last two years.

Every commercial transaction of the greatest or of the least magnitude, between individuals, or groups of whatever size, is made on the assumption that it is profitable to both parties concerned, otherwise it would not ordinarily be made. Every such transaction involves a certain degree of coöperation, a certain degree of faith or confidence in each by the other. The more the mutual confidence and the coöperative spirit, the freer and the more efficient will be the interchange and the greater the mutual profit.

The obstacles to coöperation, particularly between the larger units, are of two varieties—material, and human or intellectual. The chief material obstacles are space coupled with imperfect means of communication and transportation, differences in language, differences in coinage, weights and measures, and duties or tariffs. Some of these bear obviously only on international coöperation. The chief intellectual obstacles are tradition, custom, prejudice, suspicion, distrust, jealousy, narrow-minded and short-sighted selfishness or greed, or in general ignorance and lack of understanding one of the other. Most of this latter group bear upon minor or internal as well as upon international coöperation.

Consider first the work of engineering and industrial standardization. The work of the Standards Committee of this institute is second to none in its own particular field or in any other, either in this country or in any other country, in spite of the fact that the ground covered is a peculiarly difficult one. Why this success? Simply because of the coöperative spirit that has prevailed. Conflicting interests come together, pool their experience, share the work, place their cards on the table face up, and finally agree to abide by the resulting rules.

But this coöperative spirit does not always prevail, in fact rarely in the degree found in our Standards Committee. Until very recently the French National Committee of the International Electrotechnical Commission contained none of the designing or manufacturing engineers, it being assumed that the latter would be biased and partisan in their attitude. As a result the manufacturers formed a syndicate with a committee and standardization rules of its own, which were and even now are to some extent the rules generally employed in France, although much inferior to our own. In some cases the American rules are specified. Even now the French rules originate in the manufacturers' syndicate and are passed on to the French National Committee for their approval, with a consequent loss of time and efficiency.

As the work of our own Standards Committee expanded, we found it overlapping the work of other societies in adjacent fields, and coöperative relations were established. This failed from the lack of any suitable and generally acceptable coöperative machinery. A movement was then started by the institute more than two years ago to organize a central body (the American Engineering Standards Committee) to coördinate all the work of engineering standardization being done by the various engineering organizations. The objects of this organization are to avoid overlapping, duplication of effort and the confusion of conflicting standards; to insure the employment of an effective and sound procedure in the development of standards, to the end that a standard, when promulgated, may not only be workable but also acceptable to all concerned, and the only accepted standard of its kind; to stimulate desirable standardization and at the same time to shut off premature or ill-advised attempts at standardization.

The consummation of these objects will mean: An enormous saving of effort in the production of standards; a tremendous increase in the value and usefulness of standards; and, when the work is brought up to the needs of the time, an incalculable saving in the cost of production and the productivity of labor. International standardization will be a tremendous stimulus to foreign commerce, but such international standardization is in most cases exceedingly difficult without a central authoritative body with which similar foreign bodies may coöperate. Several instances of this difficulty which have actually arisen during the past two years could be cited, if time permitted. These have resulted in hopeless confusion, misunderstandings and waste of time and money.

Great Britain has its Engineering Standards Association, which, during its eighteen years of life, has demonstrated its reason for existence and its value to industry and to the government. Its work in aircraft standards alone, which it is doing on behalf of the government, involves some fifty-odd subcommittees.

France now has its permanent standards commission, a little more than a year old and just getting under way.

Holland also has its Normalization Bureau for the same purpose, and Switzerland is just starting a movement in this direction.

With all these national bodies our American Standards Committee has already established coöperative relations.

The American Engineering Standards Committee, although organized last October, is now in process of reorganization.

*Abstract from an address delivered at the 35th annual convention of the American Institute of Electrical Engineers, held at Lake Placid Club, N. Y., June 24 to 27, 1919.

May we not look to every member of this institute to take part in a campaign of education and in the development of that whole-hearted spirit of coöperation which will mean the support rather than the hindrance of many well meaning but timid objectors to this movement, which seems to promise so much in the development of our industries, in the increase in the productivity of labor and in the breaking down of at least one of the barriers of international misunderstanding?

Another fertile but as yet little cultivated field for coöperation is that of industrial research. Here we have a field where the obstacles of the second group are especially dominant, particularly short sighted self-interest and corporate interest, and the timid desire for secrecy.

Consider for a moment the advantages of coöperative research. Few individual corporations except the very large ones can afford either a suitable research laboratory or competent men to conduct the work. The result is that most of the research work is superficial and much of it misleading. The total cost is many times greater than of a comprehensive coöperative research led by the foremost experts in the particular field. Moreover, some of the most vital and fundamental researches are either beyond the capacity of even the largest corporation laboratories or have to be postponed for those offering more chance of immediate returns.

Now just a word as to a specific and very serious problem, namely, that arising from the world-wide unrest in the labor group. That this condition exists must be admitted by the most optimistic. To ignore it is suicidal. It is difficult to characterize this condition in a few words, as there so are many degrees of radicalism and of revolutionary spirit represented; but it may be safely stated that on the average, labor is unreasonable in its demands and seems to fail to realize that it cannot receive more wealth than it creates, or at best it has an exorbitant idea as to the value of what it creates. For example, in England labor is not only demanding higher wages, but according to all reports is reducing the hourly output as well. There seems to be a prevailing notion in labor circles that the excess profits of the capitalist constitute a limitless supply which only needs the tapping; or to put it in another way, the labor group is trying to use their organized power as a monopoly, and to insist on "all the traffic will bear." The revolutionary element goes even further than this in their demands.

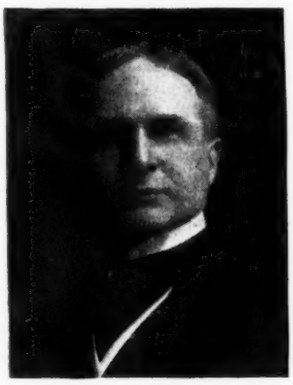
It is very easy to criticize and condemn this attitude because of its unreasonableness, looking down from our superior height of intelligence. It is very easy to assume that it is merely a matter of showing the laborer the error of his ways and of forcing him into line. But would it not be wiser at this time to examine our own attitude with equal care, to make sure that we are setting an example which, if followed by labor, would solve the problem? Is demanding all the traffic will bear under the pressure of organized labor any worse than the same policy carried out by the capitalist whenever he has the monopoly grip? Unfortunately, the two cases are not treated the same by our laws; labor monopoly is not subject to the same limitations and responsibilities as is capital monopoly; that disparity should be removed.

What can we expect of labor in the way of intelligent fair-mindedness if we, with our superior knowledge, encourage the perpetuation of institutions which work for serious injustice to the many for the benefit of the few, or even if we allow them to persist because of our lack of intelligent fair-mindedness.

My opinion as to the seriousness of the present world situation, as to the importance of the problem before us, is not mine alone, but that of many thinking men in this country and in others. I have talked with many influential men in France and England and have found a striking unanimity on this point.

May we not as engineers utilize our training and experience, our method of thought of which we are so proud, to encourage clean, straight, unbiased and fair-minded thinking, and to encourage that broad, generous, coöperative spirit which will mean so much in breaking down the barriers that separate classes within a nation, as well as the nations themselves, and which is essential to the solution of the world problem which is knocking so hard at our door.

A. I. E. E. Thirty-Fifth Annual Convention



CALVERT TOWNLEY,
President-elect, A. I. E. E.

FROM June 24 to 27 inclusive the American Institute of Engineers held its 35th annual convention at Lake Placid Club, N. Y. Approximately 400 members and guests registered. The convention was opened at 10:30 a.m., June 24, by the presentation of the annual presidential address by Comfort A. Adams, in which the great need of closer coöperation both in commercial, industrial and scientific transactions was emphasized. An abstract of this address appears on page 38 of this issue.

After delivering his address President Adams introduced President-elect Calvert Townley, who in a short address expressed his appreciation of the honor conferred upon him in being chosen as the president of the institute for the coming year. He said, much as he appreciated the honor, this was only secondary to the opportunity that the office afforded to do something for the institute. He called attention to the tremendous work that the engineer had done toward winning the war by coördinated effort, and expressed the opinion that the possibilities for the engineer making a prosperous period of peace was many times greater, providing he took advantage of his opportunities.

Before the meeting was turned over to a consideration of technical papers, at the request of the president the audience arose and remained standing in silence for a short period as a tribute to the members who had paid the supreme sacrifice in the great war.

The remainder of the session was devoted to the presentation of three papers under the auspices of the Protective-Device Committee. The first paper, "Present-Day Practice of Transmission- and Tie-Line Relay Protection," by H. R. Woodrow, D. W. Roper, O. C. Traver and P. MacGahan, was presented by Mr. Woodrow; the second, "Grounding the Neutral of Generating and Transmission Systems," by H. R. Woodrow, was presented by the author; a paper on "Grounded Neutrals," by W. E. Richards, in the absence of the author was presented by O. C. Traver.

The paper on "Present-Day Practice and Transmission- and Tie-Line Relay Protection" is a summary by the Protective-Device Committee giving the results of an analysis made of the transmission-line protective-relay situation throughout this country, by obtaining experiences of operating companies with this type of protective apparatus. Questionnaires were sent to 62 operating companies asking for their experiences and present practices in regard to relay protection; 32 companies replied. The nomenclature used by the different operating and manufacturing companies for the various classes of relays was found to be not in harmony, therefore the committee undertook the work of its standardizing, and this proposed relay nomenclature is also given in the paper.

The paper on "Grounding the Neutral of Generating and Transmission Systems" gives the methods of grounding the neutral on the New York Edison Co.'s power system, which is made up of four systems: A 6600-volt 25-cycle;

a 7800-volt 60-cycle; a 16,000-volt 25 and 60-cycle, and a 25,000-volt 25-cycle system.

The discussion brought out the opinion that the present type of relays did not give all the protection desired in the modern large power systems. Considerable of the discussion centered around the maximum time setting of the relay, it being recommended in the paper that two seconds should be the maximum on short-circuit conditions. It was brought out in the discussion that at least one large system was operating with relay settings as high as eight seconds and has never had a case of cable failure on account of long-time relay settings. However, on the New York Edison Co.'s system it has been found necessary to use a setting of even less than two seconds to take care of the short-circuit conditions which caused peak currents as high as 200,000 amperes to be delivered into the failure. Attention was called to the effects of timing relays on cable failures, experience having shown that with instantaneous settings a failure to ground would only cause a small hole to be burned in the lead sheath, without short-circuiting the cable, before the oil switch would open. The damage to the cable increases with the time required by the relay to open the oil switch, until on a setting of two or three seconds two or three feet of the cable would be burned away; and if the time setting was made too long there was danger of the arc burning through to other cables in the duct system. Good results were reported from the use of low-voltage storage batteries for tripping hand-operated oil switches. Both primary batteries have been used at pressures ranging up to about 12 volts. In some cases a preference was expressed for the use of dry cells.

Doings of the Wednesday Morning Meeting

At the Wednesday morning meeting the annual reports of the technical committees were presented.

In the report of the Power Station Committee it was announced that the committee has had under consideration for the last two years and will shortly present to the institute, the subject of "Limits of Speed and Power of Single-Shaft Steam Turbo-Generator Units." Three papers are being prepared, two covering the steam end and one the electrical end. Since the study was first considered, its realization having been retarded by the war, there occurred three or four serious mechanical failures of steam-turbine wheels which have created considerable concern to the users and aroused a wide-spread interest in one phase of this theoretical subject. The erroneous remark is often heard that it is unsafe to go beyond a certain limit in the capacity of units for central stations. In reality, units of twice or three times the power of the largest existing units can be manufactured to have the same or even greater factor of safety. Possibly such units may be more costly, or less efficient, or too heavy, or of too large dimensions, or be undesirable in situations where they would concentrate all the power of a station in two or three units instead of five or six or more, but we should not dismiss the study of the possibility of such machines simply from the wrong assumption that they cannot be made as safe as smaller-capacity units, because in some situations the larger units may yet prove to be of advantage.

In the report of the Instruments and Measurements Committee the effects of the war are reflected in the statement: "Prior to the war thermoelectric couples had been employed for measuring low values of alternating current. These couples were almost exclusively of German manufacture and neither extremely accurate nor sensitive. There have since been developed and put on the market thermo-electric couples of American manufacture which are superior in every way and are now available for the accurate measurement of alternating currents of any frequency. Their sensitivity is such that a current of one milliampere will produce a deflection of three milli-volts in a direct-current voltmeter."

It is stated in the Iron and Steel Committee's report that the increase in the use of electrical energy in the iron and steel industry in the last few years has been remarkable and partly responsible for the prominent position the United States has taken in furnishing steel products to the entire world. Over 500 motor equipments are in use in this country, driving main rolls with a maximum horsepower of over 850,000, while the total horsepower of auxiliary motors exceeds 1,350,000, making a total of 2,200,000 hp., which requires about 650,000 kw. in generator capacity. In addition, electric furnaces require approximately 250,000 kw. in generator capacity, or a grand total of 900,000 kw. generator capacity in the iron and steel industry. This is by far the largest amount of electric energy required in any one industry, and from all indications will continue to increase considerably in the future.

Future Policies Discussed

On Thursday morning a conference was held under the auspices of the Committee on Development, in which the future policies of the institute were discussed. The possibilities are that in the near future there will be a number of changes made in regards to the scope and work of the institute to meet the needs of the rapidly increasing membership. Friday morning's technical session was held under the auspices of the Transmission and Distribution Committee and four papers were presented: "High-Tension Single-Conductor Cables for Polyphase Systems," by W. F. Clark and G. B. Shanklin; "Electrostatic Field in Electric-Power Cables," by R. W. Atkinson; "Commercial Problems of 220-kv. Power Transmission," by A. E. Silver, and "The Effects of Transient Voltages on Dielectrics—II," by F. W. Peek, Jr.

A. E. Silver in his paper considers the problems of 220-kv. power transmission and suggests 220-kv. as the logical voltage for high-capacity, long-distance transmission of energy from distant coal fields and water-power plants. The author discusses very fully the important problems introduced by large concentration of energy at high voltage and covers in detail the economic and technical considerations underlying the design of a 220-kv. system. The paper indicates that while further investigation and research are necessary for a complete solution, established principles of design and present types of equipment can, with minor changes, be adopted for 220-kv. transmission.

New Jersey N. A. S. E. Meets

The annual meeting of the New Jersey State Association of the National Association of Stationary Engineers was held at Bayonne, June 7 and 8, presided over by James S. Heath of Elizabeth. National Vice President John J. Calahan was present, reporting the unusually excellent progress of the New Jersey Association, data about which is reported to him as national deputy.

There was a noticable tendency on the part of some delegates to criticize the work of the Engineers' and Firemen's License Bureau of the State Department of Labor; but appreciation of the Bureau's unavoidable difficulties led others to head off the censure.

The vigorous work of the Educational Committee, now headed by C. L. Johnson, and of the Visiting Committee is beginning to have its effect. New Jersey now stands third in membership in the national organization, having 1403 members and 13 associations. Considerable discussion was had on the appropriation for the Educational Committee. To set the members right on costs, Charles H. Bromley, of the committee, showed that the service given costs each member but 0.2c. per week.

The following officers were elected: Val V. Secor, Phillipsburg, president; George W. Armitage, Atlantic City, vice president; A. B. Meincke, Newark, secretary (re-elected); John Mycock, Trenton, treasurer; J. J. Shney, Perth Amboy, conductor; J. J. Gallagher, Bayonne, doorkeeper.

Phillipsburg is the next convention city. The convention decided to give all possible support to Atlantic City as the place for the 1920 national convention.

In Japan a little more than 1,000,000 hp. of water power is under lease for exploitation, about half of which being under exploitation or in process thereof; while about 5,000,000 hp. has not yet been placed under exploitation, although it is estimated to be worthy of future economical development.

Engineering Council Notes

Contributed by M. O. LEIGHTON, Chairman
National Service Committee

Before the writer is a pamphlet in which the following statement appears:

Let those who may shun the proper organization of the States and of the General Government for the systematic construction and maintenance of public works think of one thing: No nation has yet existed that was wholly without them, and this nation, no less than most or all of its states, in spite of all obstacles, has had them and *is constantly having them.* The question becomes reduced, then, to this simple proposition: Shall our public works be built and, what is of equal importance, maintained in a proper, businesslike manner, getting year by year a dollar's worth for a dollar's expenditure, or shall the shiftless hand-to-mouth method of procedure, which looks not forward and hides its shiftlessness by denying that we have any public works—shall this wastefulness of the public funds be allowed to continue?

The author of the pamphlet from which the foregoing is quoted is M. Clemens Herschel, Member American Society of Civil Engineers, and the date is Oct. 28, 1884. Mr. Herschel is one of the few public works department pioneers who still remain among us, and it will therefore be of interest to read what he has to say 35 years subsequent to the date of the foregoing.

New York, Feb. 17, 1919.

Mr. M. O. Leighton,
Chairman National Service Committee of Engineering Council, McLachlen Building, Washington, D. C.

Dear Mr. Leighton: Responding to the requisition you make upon me, as a member of the Engineering Council, to write out the arguments and a plant for a Department of Public Works, to form part of the Government of the United States, I comply in brief form.

It appears no longer to be necessary, as I can well remember it was necessary in times past, to argue that public works are an essential accompaniment of a civilized state. Formerly such works were, with us, called "Internal Improvements," and schools of political philosophers spent much time is proving, from their view of the Constitution of the United States, that private enterprise was all sufficient, and necessarily should be allowed solely to construct them; and again, the reverse of this proposition. That day has gone by. What Henry Clay thought about it, what those opposed to him wanted done on those lines, are both of small importance at the present day. This is a present-day nation of 110 million inhabitants, not a parcel of pioneer colonies, beginning to develop as a modern state. This is the year 1919, not 1819, when the building of the Wheeling turnpike and of the Erie and other canals first brought the Government at Washington face to face with the need of a governmental executive agency for the design and construction of public works; not to mention their repair, maintenance and operation after they had been completed.

The first use of the word engineer, as is well known, came from the exercise of refined military work. And there were none but military engineers, no others certainly in English-speaking countries, until about 1780, some 40 years before the rise of the discussion concerning "Internal Improvements" in the United States above spoken of.

Later, in America, there were, to be sure, surveyors—George Washington had been one of them—but no engineers that were noticeable, except the graduates of West Point, and other military engineers that had been imported for, and had survived from, the Revolutionary War. And so the country turned for its civil engineering, for its turnpikes and canals, to the Department of War. As an emergency measure, designated members of the Corps of Engineers, U. S. Army, were temporarily detailed to supervise the construction of these works.

The wide world over, there are today but two systems of providing for the construction and operation of public works: (1) Either to ignore the necessity for their existence in a civilized state and thus provide for them by emergency measures; or else, (2) to consider them as forming part of the every-year work of the government of a civilized state and provide for them in the fundamental law governing such states, in the same way that Departments of War, Navy, Treasury, even bodies exercising police powers or the judiciary, are provided for.

The great exemplar of relying for all public works upon private enterprise is England. When public works had to be built, harbor works, works of water supply, metropolitan sewerage, and others, the emergency system was followed. For each case a select body of laymen, a so-called commission, would be appointed, and an emergency corps of civil engineers gathered as an executive agency. The commission would studiously, and in some measure, qualify itself for its task; works would be executed, and the whole organization would then dissolve into its original elements. Of course there are exceptions to and variations from this normal state of affairs. And England, it may be said, has grown heartily tired of its want of organization for purposes of constantly recurring and as constantly necessary work, which has been described. The light is beginning to break in upon them, as it must sooner or later upon the imitators of England—the United States, and the dependencies of Great Britain.

The English system of emergency measures are an anomaly in these days of a striving for efficiency, and are gradually changing for a better system of carrying on the normal year's work of the Commonwealth, both in England and in the British Dominions. That the United States and the 48 state governments are moving and will continue to move in the same direction many signs indicate.

The other method for a state to care for its public works, a host of our civil engineers and others have no doubt recently seen in operation, even in war times, in France; and it is the same in all the other European Continental countries. The Minister of Public Works, an important member of the Cabinet, stands at the head of the organization. In the United States, let me say at once, the Secretary of the Interior could, without much disturbance, be converted into such a Secretary for Public Works.

His former principal duties, those relating to public lands, and to the wards of the Nation, the Indian tribes, are rapidly becoming obsolete, and would naturally be followed by those relating to other constantly obtaining domestic needs of the country.

See how the engineering requirements of the United States are now distributed among the departments, with much unavoidable duplication and waste of work.

LIST OF ENGINEERING BUREAUS OR COMMISSIONS
Under Various Executive Departments of the United States Government

Treasury: Supervising Architect, Public Health Service.
War: Construction Division of the Army, River and Harbors, Public Buildings and Grounds, Mississippi River Commission, California Débris Commission, Engineering in Philippines, Porto Rico, etc.
Navy: Steam Engineering, Civil Engineering, Docks, etc., Experiment Stations.
Interior: General Land Office, All Land Surveys, Geological Survey, Bureau of Mines, Reclamation Service, National Park Service, Alaskan Engineering Commission, Engineering in office of Indian Affairs.
Agriculture: Roads and Engineering, Forestry Engineering.
Commerce: Coast and Geodetic Survey, Bureau of Standards, Bureau of Lighthouses.

The great change that must come, if public works are do the permanent civil engineering work of the United is that of constituting a permanent corps of civil engineers to do the civil-engineering work of the country, under a Secretary for Public Works such as described. It is the only efficient way. Organizations built up as emergency measures must give way to it. Army organizations can readily confine themselves to the work of the Army, and let a commissioned, permanent body of U. S. civil engineers to do the permanent civil engineering work of the United States.

Yours very truly,
CLEMENS HERSCHEL.

American Boiler Manufacturers' Association Meets

The thirty-first annual convention of the American Boiler Manufacturers' Association was called to order at the Lafayette Hotel, Buffalo, promptly at 10 o'clock on Monday, June 23, by President W. C. Connelly. Richard Hammond, charter member and past president of the association and a resident of Buffalo, spoke a few words of welcome.

Reports were submitted by E. R. Fish and Charles E. Gorton regarding the work of the Uniform Boiler Law Society.

H. N. Covell, secretary and treasurer, reported the association in a flourishing condition financially and otherwise, with no resignations, 8 new member companies and 4 new associate members during the year, making 86 active member companies. Dr. D. S. Jacobus presented a paper on "Methods of Increasing Boiler Room Efficiency."

The annual address of the president was the first business of the afternoon. Excerpts from the address follow:

Perhaps the most serious of our readjustment problems pertains to labor. Many of the large activities of a year ago no longer exist, and industry for several months past has been shifting from "war needs" to "peacetime needs." This adjustment is practically made and in much less time than most of us had even hoped for.

During the war Government control was largely in effect and in some instances Government operation of industry was in vogue. The latter has proved so great a failure, from both an operating and a financial viewpoint, that I believe this association should do as others have been doing and pass a resolution calling for prompt return to their owners of all semipublic or private companies which the Government has been operating.

The subject is a large one, and I do not wish to be understood as having expert knowledge of it—but I do know that American industry cannot carry as heavy a taxation burden as now exists, and prosper.

There can be no lowering in the cost of living while the present high rate of wage, which prevailed during the war, continues. It must be plain to anyone who has given the subject the least thought that labor is the "base of all costs"—therefore, as the cost of labor advances, so will those things which labor needs in its everyday life advance. At present, the steel which all of us purchase costs about 100 per cent. more than it did before the war, and the labor we put on to that steel in the manufacture of boilers costs about the same percentage additional, with the result that we are obliged to sell our finished product at about 100 per cent. above its former price.

An organization or Federation of American Industries was established in 1916, having headquarters at 15 Beacon St., Boston, Mass., and it might be desirable to empower your Executive Committee to study the work of the National Industrial Conference Board, with a view of lending our moral and financial assistance.

I offer the opinion that 50 productive hours of labor per week is the point at which American industries must stop, and this total be divided into five days of nine hours each, and one day of five hours.

It is time to make a stand that industry cannot survive on tools, buildings, etc., idle more than 66⅔ per cent. of the time.

The president offered the following recommendations:

In the interest of standardization we should all agree to build nothing but A. S. M. E. boilers.

That technical and trade papers carrying advertisements of boilers built by members of our association be requested to properly group these advertisements on successive pages.

That a committee make a study of the workman's compensation laws of the various states, with a view of harmonizing, as nearly as possible, the rates of insurance for our industry, and also to find out what it has cost the various states to carry our risks, as against the amount of premium we have paid in.

That builders of fire-tube boilers (especially horizontal return-tubular type) compile a standard form of specification and cover all of the items requisite to a good setting.

That the convention consider the holding of quarterly or semiannual meetings of this association, for the purpose of general advancement.

In conclusion the president said:

I wish to express my grateful appreciation of the efforts and encouragement of all the members of your Executive Committee in advancing the work of the association. I also feel that special mention should be made of the services rendered by the War-Service Committee, consisting of Messrs. Barnum, Fisher and Bach. The amount of time these gentlemen have given to this work can only be appreciated by those who, like myself, had the opportunity of knowing. I should be derelict in my duties if I failed to mention the services of Mr. Covell, as secretary and treasurer of this organization. At no time in the past year have I asked for aid on association matters that it was not forthcoming promptly. I again extend my thanks to all our members for their loyal support. The friendships which have come to me from these meetings I greatly prize, and hope that each of you have had an equal amount of pleasure from them.

A discussion regarding the registering of boilers in the state where they are made and in the state into which they are shipped was led by E. C. Fisher.

A discussion regarding the use of trade acceptances in the settlement of accounts receivable and also of accounts payable followed.

A proposal to standardize pressures for water-tube boilers at 160, 180, 200, 225, 250, 275 and 300 lb. was adopted unanimously by the representatives of the water-tube boiler manufacturers present and 100, 125 and 150 lb. by the manufacturers of horizontal return-tubular boilers.

A. G. Pratt of the Babcock & Wilcox Co. gave the following figures for 1918 and 1919:

(1918) Pressure	Jobs	Boilers	Per Cent. Jobs	Per Cent. Boilers
160	257	515	53.6	45.4
180	19	38	4.0	3.3
200	167	434	34.8	38.2
225	13	53	2.7	4.7
250	17	64	3.5	5.6
275	2	8	0.4	0.7
300	4	17	0.8	1.5
350	1	6	0.2	0.5
	480	1135	100.0	99.9
160	80	161	61.1	63.2
180	6	21	4.6	8.2
200	37	58	28.2	22.8
225	6	12	4.6	4.7
250	2	3	1.5	1.1
	131	255	100.0	100.0

These were not normal years and the figures are quite different when computed by horsepower instead of by boilers, but they are interesting as they stand.

The remainder of the afternoon was taken up with a topical discussion of the proportions of boiler settings, which will be treated at length in a future number. Tuesday forenoon was devoted to an executive session.

Activities of the American Association of Engineers

F. K. Bennett, president of the Twin City chapter of the American Association of Engineers, has been appointed chairman of a joint engineering committee representing the Engineers' Club of Minneapolis and the Twin City chapter of the American Association of Engineers. The duties of this committee will be to help in the solution of engineering problems arising in connection with the settlement of the street-railway franchise in the Twin Cities.

A permanent organization of the Portland, Ore., chapter of the American Association of Engineers has been effected. A committee of the Oregon Society of Engineers has been appointed by its Executive Board to work out plans for amalgamation with the American Association. A tentative plan has been drawn and was submitted to the national board of directors of the A. A. E.

At the convention of the Southwestern Society of Engineers, held in El Paso, May 29 and 30, the board of the society voted unanimously to recommend to its members that the Southwestern Society come into A. A. E. as a body. The tentative plan is to charter the Southwestern Society as the Southwestern District of the A. A. E.

The Navy Technical Association, consisting of 700 civilian engineers in navy yards at Boston, Newport, Hartford, New York, Schenectady, Philadelphia, Washington, Norfolk and Hampton Roads, has been amalgamated with the A. A. E. Final steps were taken by delegates of the Association at its convention in Washington June 8-9, and the arrangement was approved by the National Board of Directors of the A. A. E. at its meeting June 14.

The A. A. E. has employed B. C. Baily, president of the N. T. A. and formerly expert aide at the Brooklyn Navy Yard, as its assistant secretary in Washington, D. C.

When the suction pipe of a pump has been installed, it should be tested at from 35 to 50 lb. hydraulic pressure, for even a minor leak will furnish a sufficient quantity of air to impair the pump's action. The suction line should be thoroughly inspected for tight connections.

Personals

E. B. Katte, well-known electrical engineer, who has been for many years chief engineer of electric traction of the New York Central R.R., has been elected president of the New York Electrical Society.

Van H. Manning, director of the United States Bureau of Mines, Washington, had the honorary degree of doctor of engineering conferred upon him at the recent commencement of the University of Pittsburgh, in special recognition of his activities in aiding the winning of the war.

Eugene L. Brown, Jr., has recently been discharged from military service, and has accepted the position of chief engineer of the stoker department with the Plymouth Manufacturing Co., Chicago. Before entering the Army, Mr. Brown was connected with the Illinois Stoker Co., Alton, Ill.

Major Charles E. Sholes has been elected vice president, director and general sales manager of the Edison Storage Battery Co., Orange, N. J., to succeed Harrison G. Thompson, who resigned to organize and conduct the Transportation Engineering Corp., of New York. Major Sholes has heretofore been identified with the construction, operation and management of chemical industries.

C. S. Coler, who has been successively director of mechanical drawing in the Casino Technical Night School, an institution supported by the Westinghouse company to promote the education of the young men and women working for the company, manager of the entire evening school, and director of the trades training of the company, has recently been appointed manager of the educational department of the company and president of the Casino Technical Night School. This appointment was made possible by the resignation of C. R. Dooley, who has accepted a position with the Standard Oil Co. to promote educational work in that organization.

Engineering Affairs

The Ohio Electric Light Association will hold its annual meeting at Cedar Point, Ohio, July 15-18, with headquarters at the Breakers Hotel.

The American Association of Engineers formed a new chapter at Dallas, Texas, May 23, which resulted in the organization of a Dallas Engineers' Club to include all engineers of the city.

The Association of Iron and Steel Electrical Engineers, Birmingham (Ala.), Section, will hold an outing on July 4 at the hydro-electric plant of the Alabama Power Co., on the Coosa River.

The Brooklyn Company Section, N. E. L. A., held its annual meeting in the auditorium of the Central Y. M. C. A., Brooklyn, on the evening of June 10, over 500 being in attendance. The meeting was called to order by the chairman, R. W. Allen, who presented his annual report, with which was incorporated reports of the treasurer and the following standing committees: Editorial, Meetings, Membership, Papers and Competition, Speakers and War Activities. The reports showed a very active year in the Brooklyn Section under the unusual and uncertain conditions existing during the war period, and that following the signing of the armistice. All the meetings of the section were thrown open to all employees of the company, whether members or not, and no especial membership drive was attempted. Following the report of the chairman, H. M. Cook presented a report on the Atlantic City convention, outlining in detail the work of several of the sessions. The feature of the evening comprised several addresses by men who left the company to take active part in service abroad. These addresses were varied and full of human interest, being greatly enjoyed by all present. E. A. Baily, who was elected chairman of the section for the coming year, on behalf of the company, presented to Past Chairman Allen the past chairman's gold watch fob, which insignia is awarded by the Brooklyn Company to each past chairman of the Brooklyn Section in recognition of his services. The meeting concluded with a motion picture and a selection by the orchestra.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.15@2.75	$2.75@3.25
Philadelphia, gross tons	4.27@4.95	5.95@5.50
New York, gross tons	4.62@5.29	5.29@5.85
Alongside Boston (water coal), gross tons	6.10@6.85	6.90@7.55

Pocahontas and New River are quoted at $4.70 @5.25 f.o.b. Norfolk and Newport News, Va., for spot coal, and $7.20@8.60 alongside Boston, these prices being on a gross ton basis.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Company Circular		Mine	Company Circular
Broken	$6.05	$7.90	Pea	4.90	6.65
Egg	5.95	7.80	Buckwheat	3.40	5.15
Stove	6.20	8.05	Rice	2.75	4.50
Chestnut	6.30	8.15	Barley	2.25	4.00

Bituminous

	Spot	Contract
South Forks	$2.90 @ $3.25	$2.95 @ $3.50
Cambria County (good grades)	2.75 @ 2.95	2.95 @ 3.25
Clearfield County	2.50 @ 2.75	2.80 @ 2.95
Reynoldsville	2.50 @ 2.75	2.75 @ 2.95
Quemahoning	2.65 @ 2.85	2.95 @ 3.10
Somerset County (best grades)	2.50 @ 2.75	2.95 @ 3.10
Somerset County (poorer grades)	2.00 @ 2.35	2.50 @ 2.75
Western Maryland	2.25 @ 2.50	2.50 @ 2.75
Fairmont	2.00 @ 2.25	2.35 @ 2.50
Latrobe	2.10 @ 2.25	2.25 @ 2.40
Greensburg	2.25 @ 2.35	2.35 @ 2.60
Westmoreland	2.60 @ 2.75	2.60 @ 2.75
Westmoreland run-of-mine	2.35 @ 2.60	2.35 @ 2.65

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.05	7.90	Rice	2.75	3.65
Stove	6.30	8.15	Boiler	2.50	3.50
Nut	6.40	8.25	Barley	2.25	3.15
Pea	5.00	6.60	Culm	1.25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2.35@2.50	3.00
Screenings	1.85@2.20	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.45	$2.75	$2.40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	....	5.25	.....

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4.60
Corona	3.50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut	$2.75	.....
Williamson County Prepared sizes, lump, egg, nut	$2.55	$2.55	$2.00@2.25
Mine-run	2.35	2.20	1.60@1.75
Screenings	2.20	2.05	1.15@1.30
3-in. lump	....	2.30	.....
2-in. lump	....	....	1.75@1.90

Williamson-Franklin rate to St Louis is $1.07; other rates 92½c.

New Construction

PROPOSED WORK

N. Y., Central Islip—The State Hospital Commission, Capitol, Albany, will soon award the contract for installing one 600 hp. boiler, 4 stokers, new coal bunker and conveyor, etc., at the Central Islip State Hospital here. Estimated cost, $200,000.

N. Y., New York—The New York Edison Co., Irving Place and 15th St., plans to build a 3 story, 45 x 75 ft. transformer station at 421-423 East 6th St. Estimated cost, $60,000. W. Whitehill, 32 Union Square, Arch.

N. Y., Oswego—The Hinckly Towing Co. will install pumps, cranes, etc., in connection with the dry-dock-marine railway which it plans to build. Total estimated cost, $100,000.

N. Y., Pierrepont Manor—The Northern New York Milk Co. recently incorporated with $500,000 capital stock will install boilers, electric power motors and an ammonia ice plant in connection with the milk station, evaporating plant and milk shipping station which it plans to build. Estimated cost, $200,000. Address F. P. Redfield, Adams, Dir.

N. Y., Potsdam—T. E. Finegan, Deputy Comr. of Education, Education Bldg., Albany, will soon award the contract for the construction of a 54 x 64 ft. boiler house, etc., at the Potsdam Normal School here. Estimated cost, $85,000. L. F. Pilcher, Capitol, Albany, State Arch.

N. Y., Rockaway—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to build an electric light and power distributing system, at the Naval Air Station here. Estimated cost, $60,000 Specification No. 3958.

N. Y., Utica—The Board of Education has authorized J. Kemper, City Engr., to receive bids for installing a new heating and air washing system in School No. 18. Estimated cost, $14,500.

N. J., Jersey City—The Eastern States Refrigerating Co., 147-16th St., plans to build a 7 story plant on Provost St. Estimated cost, $150,000.

N. J., Rahway—The city plans to build a river terminal on the Rahway River, to include cold storage warehouses, sheds, etc. Total estimated cost, $2,400,000. H. Mc. L. Harding, 52 Vanderbilt Ave., New York City, Engr.

Md., Baltimore—The Standard Oil Co., Pier 2, Pratt St. plans to build an engine and pump house at Hanover and Barney St.

D. C., Washington—The Board of Commissioners, Room 511, District Bldg., will soon award the contract for the construction of a small pump house at the municipal fish market on Water St., between 11th and 12th St., Southwest.

W. Va., Huntington—J. M. McCoach Co., 7th Ave. and 13th St., will receive bids in the fall for the construction of a 4 story addition to its ice and cold storage plant, to increase the ice capacity from 120 to 225 tons daily and cold storage from 30,000 to 100,000 bbl. daily. Estimated cost, $200,000. Architect not selected.

S. C., Williston—L. S. Williston, Clk., Comrs. of Pub. Wks., will soon award the contract for establishing a water works system. Plans include the construction of a deep well pumping station, etc Estimated cost, $30,000.

Ga., Alma—The city plans to build an electric light plant. J. B. McCrary Co., 3rd National Bank Bldg., Atlanta, Engr.

Ga., Unadilla—The city plans to build an electric light plant. Estimated cost, $15,000. J. B. McCrary Co., 3rd National Bank Bldg., Atlanta, Engr.

Fla., Key West—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will soon award the contract for the construction of a power house and installing electric generator equipment and fire protection system here. Estimated cost, $105,000. Specification No. 3956 Noted May 27.

Ohio, Cleveland—The Frantz Premier Co., Ivanhoe Rd., is in the market for one second hand, 6 to 12 volts, 1000 amperes electric plating generator, also one 12-in. Hendey lathe with or without taper attachment.

Ohio, Cleveland—The Republic Motor Truck Co., Alma, Mich., has awarded the contract for the construction of a service building, gas engine plant, etc., on Babbitt Rd. here, to Westinghouse, Church & Kerr, 37 Wall St., New York City. A steam heating system will be installed in same. Total estimated cost, $10,000,000.

Mich., Kalamazoo—The Western Board & Paper Co. will install a power house for steam plant with mechanical coal conveyors, automatic stokers, etc., in connection with the 3 story, 60 x 218 ft. stock house which it plans to build.

Ill., Chicago—The Anchor Leather Co., Division and Hickory St., has awarded the contract for the construction of a 3 and 1 story, 104 x 148 ft. factory, to Van Etten Bros., 143 East 111th St. A 200 h.p. high pressure boiler will be installed in same. Estimated cost, $65,000.

Ill., Columbia—The Village Clerk will soon award the contract for the construction of improvements to the electric light and power plant; to be divided in Sect. 1, building extension and machinery foundations: Sect. 2, 100 hp., H.R.T. boiler and breeching; Sect. 3, 100 ft. x 4 in. concrete chimney; Sect. 4, 120 hp. non-releasing Corliss or Unaflow engine; Sect. 5, heater, boiler, feed pump, pipe work and covering; Sect. 6, direct connected A. C. generator, exciter, transformer and switchboard. Fuller Beard, Chemical Bldg., St. Louis, Mo., Engr.

Wis., Carrollville (Otjen P. O.)—The U. S. Fertilizer Co., c/o the U. S. Glue Co. will install motors in connection with the fertilizer plant which it plans to build. Estimated cost, $100,000. H. J. Esser, Camp Bldg., Milwaukee, Engr.

Wis., Eau Claire—The city plans to improve the water works system. Plans include new well, centrifugal pump, water wheel generator at the pumping station and concrete flume. Estimated cost, $100,000. A. R. Garnock, 1000 Guardian Life Bldg., St. Paul, Minn., Engr.

Wis., Milwaukee—W. R. Callahan, Purch. Agt., of the Central Board of Purchases, City Hall, will receive bids until July 16 for furnishing one 20,000,000 gal. pumping engine at the North Point Pumping Station. Estimated cost, $250,000. G. F. Staal, City Hall, City Engr.

Minn., Austin—The Board of Education is having plans prepared by F. Tustison, Arch., 355 Auditorium Bldg., Minneapolis, for the construction of a central boiler plant and mechanical equipment for the junior and senior high school, for old and new buildings. Estimated cost, $150,000.

Minn., Austin—The State Board of Control, Capitol, St. Paul, will soon award the contract for installing a boiler and stoking plant at the municipal electric pant here. C. L. Pillsbury Co., 801 Metropolitan Life Bldg., Minneapolis, Engr.

Minn., Brainerd—The city will receive bids until July 7 for improving the waterworks system. Project includes the construction of a pumping station with electrical pumping equipment, etc. Total estimated cost, $250,000. L. P. Wolff, 1001 Guardian Life Bldg., St. Paul, Consult. Engr. Noted Apr. 22.

Minn., Hastings—The State Board of Control, Capitol, St. Paul, will soon award the contract for the construction of a power plant. Estimated cost, $150,000. C. L. Pillsbury, Metropolitan Life Bldg., Minneapolis, Engr. Noted May 13.

Minn., Minneapolis—The State Board of Control, Capitol, St. Paul, will soon award the contract for the construction of new generating units for the electric light plant, to include fire alarm system, refrigerating plant, etc. Estimated cost, $75,000. C. L. Pillsbury Co., 801 Metropolitan Life Bldg., Engr. Noted June 24.

Kan., Sharon Springs—The city voted $50,000 bonds for the construction of a power plant, installing one 105 and one 100 hp. engines and improving the distributing system. Noted June 3.

N. D., Amenia—The Amenia & Sharon Land Co. will soon award the contract for the construction of a power house; oil engines and accessories for two 3 phase, 60 cycle, 2300 volt alternators, etc. E. D. Jackson, 601 Capital National Bank Bldg., St. Paul, Minn., Engr.

Mo., St. Louis—The Monarch Weather Strip Co., 4121 Forest Park Blvd., is in the market for several 3 hp. motors and three or four ¾ hp. motors, etc. J. A. Coellner, Supt.

Idaho, Boise—The State will install 1 or 2 water tube boilers to add to the present steam heating plant, and electrically driven centrifugal ventilating fans for double system, in connection with the addition to the State Capitol building which it plans to build on Jefferson St. Total estimated cost, $900,000. W. J. Hall, Comr. of Pub. Wks. Tourtellote & Hummell, Overland Bldg., Arch.

Ore., Florence—The city voted $2000 bonds for the construction of a light and water plant and is in the market for a Diesel engine. Address the City Marshall.

Ore., Salem—The Clackamas Power & Irrigation Co., Clackamas, has filed application with H. Nunn, State Highway Engr., for development of 11,705 hp. plant, 1000 acre-ft. of water to be taken from the Clackamas River. Plans include a 400 ft. dam, 103 ft. water fall, 6.6 mi. flume and ditch. Total estimated cost, $1,250,000.

Cal., Avalon—The city voted $88,000 bonds for the construction of a combined electrc light and water works plant on Catalina Island here. Noted June 17.

Cal., Coburn—Switzer & Meyemberg will install two 100 hp. steam boilers and refrigerating machinery in connection with the 2 story creamery which it plans to build. Total estimated cost, $45,000. F. R. Spangler, King City, Arch.

Cal., Fresno—A Mattei will install a steam heating plant and electric power plant in connection with the 12 story, 50 x 150 ft. office building which it plans to build on Fresno and J St. Total estimated cost, $400,000. E. Mathewson, 428 Cory Bldg., Arch.

Cal., Palo Alto—The city plans election soon to vote on $72,000 bonds for installing a Diesel engine for generating electricity for the lighting plant. J. F. Byxbee, Jr., Engr.

Cal., Visalia—The Visalia National Bank & Trust Co. will install a steam heating plant in the 4 story, 83 x 116 ft. bank and office which it plans to build on Main and Church St. Total estimated cost, $200,000. E. J. Kump, 227 Powell Bldg., Fresno, Cal., Arch.

CONTRACTS AWARDED

Mass., Boston—The Commissioner of Public Works received bids for installing condensers at the Calf Island Pumping Station here, from the Schumaker Santry Co., 141 Milk St., $10,334; Power Equipment Co., 131 State St., $10,800.

Mass., Boston—The School Commission received bids for installing a heating plant in the Gibson School, from J. J. Hurley, $13,952; F. W. Zemier, 154 Pearl St., $14,367; J. P. Dwyer, 183 Harrison Ave., $14,700. J. P. Lomasney, City Hall, Chn. Schoolhouse Comm.

Mass., Chelsea—The Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids for extending the heating plant and distribution system here, work complete, from the Power Efficiency Corp., White Bldg., Buffalo, N. Y., $54,886; Lynch & Woodward, 287 Atlantic Ave., Boston, Mass., $57,432; Lord Construction Co., 112 Water St., Boston, Mass., $59,927. Specification No. 3891.

Conn., New Haven—The Seamless Rubber Co., 534 Congress Ave., has awarded the contract for the construction of a plant on Hallock Ave., to the Aberthaw Construction Co., 27 School St., Boston, Mass. Plans include the construction of a large power house. Total estimated cost, $500,000.

N. Y., Central Islip—The State Hospital Commission has awarded the contract for installing a heating plant at the Central Islip State Hospital here, to W. B. Armstrong Co., 3 Fulton St., Albany. Estimated cost, $22,842. Noted May 27.

N. J., Bayonne—The city received bids for furnishing 2 high powered contrifugal pumps to increase the water pressure throughout the city from the Buffalo Steam Pump Co., 39 Cortlandt St., New York City (no definite figure, but asked to submit estimate later); Dugan Forest Engineering Co., Motor driven pump on concrete foundation provided by the city, $9520; Worthington Pump Co., 115 Broadway, New York City, $8700; J. R. Proctor, Inc., 721 Broadway, Bayonne, 7 styles ranging in price from $7191 to $10,093.

Penn., Philadelphia—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for installing a heating and humidifying and Dew Point control system at the Aircraft Storage Building here, to the Enterprise Steam & Hot Water Heating Co., 600 North Howard St., Baltimore, Md., $62,529. Noted May 27.

Md., Highlandtown (Baltimore P. O.)—Jones & Lamb Co., Pennsylvania and Fulton Ave., Baltimore, has awarded the contract for remodeling the Monumental Brewery plant into a meat packing plant, oil refinery and ice plant, to the Consolidated Engineering Co., 243 Calvert Bldg., Baltimore. Estimated cost, $250,000. Noted April 29.

Ohio, Cincinnati—The Treasury Department, Superv. Archt's. office, received bid for installing boiler here, from the Heine Safety Boiler Co., 5319 Marcus St., St. Louis, Mo. $39,930, (195 days).

Business Opportunities
Equipment Bargains
Wants
Jobs
Men

Men
Jobs
Wants

Business Opportunities
Equipment Bargains
Wants
Jobs
Men

Equipment Bargains
Business Opportunities

all the worth-while "Opportunities" of the power plant field. You will find them in the

SEARCHLIGHT SECTION

SEE PAGES 92 TO 102.

PRICES - MATERIALS - SUPPLIES

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

	Fire 50-Ft. Lengths
Underwriters' 2½-in.	70% per ft.
Common, 2½-in.	40–10%

	Air		
	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.45	$0.30	$0.20

Steam—Discounts from List

First grade 35% Second grade 45% Third grade 50%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition 65% Best grade 40%
Standard 50–10%

Note—Above discounts apply on new list issued **July 1.**

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	45%	35%
St. Louis	45%	35%
Chicago	45%	40%
Birmingham	35%	35%
Denver	35–5%	30%

RAWHIDE LACING—20% for cut; 45c. per sq. ft. for ordinary.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.90
Asbestos for high-pressure steam	1.60
Duck and rubber for piston packing	1.00
Flax, regular	1.20
Flax, waterproofed	1.60
Compressed asbestos sheet	1.00
Wire insertion asbestos sheet	1.20
Rubber sheet	.60
Rubber sheet, wire insertion	.80
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.20
Asbestos wick, ½- and 1-lb. balls	.85

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin. Ft.	Thickness	Price per Sq. Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure List

For low-pressure heating and return lines: 4-ply 58% off; 3-ply 60% off; 2-ply 62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Pittsburgh	Chicago	St. Louis	Birmingham	Denver
Cup	7	9	5¼	7	8½	14½
Fiber or sponge	8	10	6	13	8½	18
Transmission	7	9	6	13	8½	20
Axle	4½	6	4	4.75	4	5¼
Gear	4½	9	4½	7.5	8½	8
Car journal	22(gal.)	21 (gal.)	3½	4.9	8½	8

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	11.00 to 13.00	13.00	14.00	11.00 to 14.00
Colored mixed	8.50 to 12.00	12.00	11.00	9.50 to 12.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½ x 13½	13½ x 20½
Cleveland	$52.00	$58.00
Chicago	41.00	43.50

LINSEED OIL—These prices are per gallon:

	New York		Cleveland	Chicago		St. Louis
	Current	One Year Ago	Current	Current	One Year Ago	Current
Raw in barrels	$1.93	$1.61	$2.00	$2.10	$1.66	$1.69
5-gal. cans	2.06	1.71	2.25	2.30	1.86	1.75

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current Dry and In Oil	1 Yr. Ago Dry and In Oil
	Dry	In Oil	Dry	In Oil		
100-lb. keg	13.00	14.50	11.25	11.50	13.00	10.50
25- and 50-lb. kegs	13.25	14.75	11.50	11.75	13.25	10.75
12½-lb. keg	13.50	15.00	11.75	11.00	13.50	11.00
1-lb. cans	15.00	16.50	13.25	13.00	15.00	13.00
5-lb. cans	16.00	17.50	13.25	13.50	16.00	13.00

500 lb. lots less 10% discount; 2000 lb. lots less 10–2½%.

AMMONIA—Price per pound in St. Louis for 26 deg. U. S. P., 100-lb. carboys, is 8½c.; in 1000-lb. drums, 7c.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ½ and smaller	65%	60–5%	45%
Tinned	65%	60–5%	40%

Boiler rivets, ½, ⅝, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York....$6.35 Cleveland...$4.00 Chicago...$4.87 Pittsburgh...$4.65

Structual rivets, same sizes:

New York....$6.25 Cleveland...$4.10 Chicago...$4.97 Pittsburgh...$4.75

REFRACTORIES—Following prices are f. o. b. works, Pittsburgh:

Chrome brick net ton	$120.00 at Chester, Penn.
Chrome cement net ton	65.00 at Chester, Penn.
Clay brick, 1st quality fireclay net ton	40–30 at Clearfield, Penn.
Clay brick, 2nd quality net ton	38–48 at Clearfield, Penn.
Magnesite, dead burned net ton	32.50 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in. net ton	80–90 at Chester, Penn.
Silica brick net ton	45–55 at Mt. Union, Penn.

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—Fire Clay, $30 to $40.
Birmingham—Fire clay, $41–$44; silica, $46, $50-$15.50 magnesite, $80-$85; chrome, $80-$90.
Chicago—Second quality, $25 per ton.
Denver—Silica, $35 per 1000.

FUEL OIL—Domestic light, 22-26 deg., Baume, is 8½c. per gal. in St. Louis.

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	87.00	125.00	79.00	100.00	75.00	113.00
Commercial	42.00	70.00	18.50	22.00	15.00	23.00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$25.50–30	$15.00
Cleveland	20.00	15.00
Chicago	16.50	15.00

In coils an advance of 50c. usually is charged.
Domestic iron (Swedish analysis) is selling at 15c. per lb.

POLES—Prices on Western red cedar poles:

	New York	Chicago	Denver	San Francisco
6 in. by 30 ft.	$5.82	$5.17	$4.55	$5.17
7 in. by 30 ft.	7.65	6.85	6.10	6.85
7 in. by 35 ft.	11.10	10.00	8.95	10.00
8 in. by 35 ft.	12.65	11.35	10.10	11.35
7 in. by 40 ft.	12.85	11.50	10.20	11.50
8 in. by 45 ft.	18.90	16.90	15.00	16.90
8 in. by 50 ft.	22.65	20.30	18.00	20.30

10c. higher freight rates on account of double loads.
For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft	$9.00
12-in. butts, 6-in. tops, length 30-40 ft	11.50
12-in. butts, 6-in. tops, length 41-50 ft	12.50
14-in. butts, 6-in. tops, length 51-60 ft	21.00
14-in. butts, 6-in. tops, length 61-71 ft	23.50

PIPE—The following discounts are for carload lots f. o. b. Pittsburgh; basing card of Jan. 1, 1919, for steel pipe and for iron pipe:

BUTT WELD

Inches	Steel Black	Steel Galvanized	Inches	Iron Black	Iron Galvanized
⅛, ¼, and ⅜	50½%	24%	¾ to 1½	39½%	23½%
½	54½%	40%			
¾ to 3	57½%	44%			

LAP WELD

2	50½%	38%	2	32½%	18½%
2½ to 6	53½%	41%	2½ to 6	34½%	21½%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜	46½%	25%	¾ to 1½	39½%	24½%
½	51½%	39%			
¾ to 1½	55½%	43%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	48%	37½%	2	33½%	20½%
2½ to 4	51%	40½%	2½ to 4	35½%	23½%
4½ to 6	50%	39½%	4½ to 6	34½%	22½%

Stock discounts in cities named are as follows:

	New York Black	New York Galvanized	Cleveland Black	Cleveland Galvanized	Chicago Black	Chicago Galvanized
⅜ to 3 in. steel butt welded	47%	31%	46½%	31%	57½%	44%
2½ to 3 in. steel lap welded	42%	27%	42½%	27½%	51½%	41%

Malleable fittings. Class B and C, from New York stock sell at list + 12½%.
Cast iron, standard sizes, 10% off.

BOILER TUBES—The following are the prices for carload lots, f. o. b. Pittsburgh:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	40½	3½ to 4½ in.	15½
2½ to 3¼ in.	30½	3 to 3¼ in.	1
2¼ in.	24	2½ to 2¾ in.	+ 1
1¾ to 2 in.	19½	2 to 2¼ in.	+1½
		1¾ to 1¾ in.	+29

Standard Commercial Seamless—Cold Drawn or Hot Rolled

Per Net Ton		Per Net Ton	
1 in.	$327	1¾ in.	$207
1¼ in.	267	2 to 2½ in.	177
1½ in.	257	2¾ to 3¾ in.	167
1¾ in.	207	4 in.	187
		4½ to 5 in.	207

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.

ELECTRICAL SUPPLIES

ARMORED CABLE—

B.&S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$104.00	$138.00	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

	Net List
Less than coil lots	
Coils to 1,000 ft.	10%
1,000 ft. and over	15%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever Ready

	Each, Net
Less than 12	$0.40
12 to 50	.38
50 to 125 (bbl.)	.35
125 (bbl.) or over	.32

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per 100 for couplings and elbows:

	Conduit		Elbows		Couplings	
Size, In.	Black 1,000 Ft. and Over	Galvanized 1,000 Ft. and Over	Black 100 and Over	Galvanized 100 and Over	Black 100 and Over	Galvanized 100 and Over
⅜	$71.15	$76.25	$17.04	$18.18	$5.38	$5.74
½	71.15	76.25	17.04	18.18	6.28	6.70
¾	93.96	100.86	22.43	23.93	8.97	9.57
1	138.39	149.09	33.19	35.41	11.66	12.44
1¼	187.91	201.71	42.62	45.31	16.10	17.12
1½	224.68	241.18	56.82	60.62	19.89	21.15
2	302.29	324.49	104.17	110.77	26.52	28.20
2½	477.95	513.05	170.46	181.26	37.88	40.28
3	625.00	670.91	454.56	483.36	56.82	60.42
3½	779.24	834.44	1,003.82	1,067.42	75.76	80.56
4	945.03	1,010.43	1,160.08	1,233.57	94.70	100.70

5% cash 10 days.
From New York Warehouse—Less 5% cash.
Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.
⅜	250	$0.05½
½	250	.06
¾	250	.09
1	200	.12
1¼	200	.15
1½	150	.18
1	100	.25
1¼	100	.33
1½	Odd lengths	.40
2	Odd lengths	.55

Coils..... 55% off
Less coils, 45% off

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. I.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. I.	.18	T. P. to D. P. T. B.	.38
T. P. M. I.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. I.	$0.33	$0.84	$1.68
T. P. M. I.	.48	1.20	2.40
D. P. S. B.	.42	1.05	.....
T. P. S. B.	.81	1.80	.....
D. P. D. B.	.78	2.10	.....
T. P. D. B.	1.35	3.60	.....
T. P. to D. P. D. B.	.90	2.52	.....

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$16.75
No. 16 cotton twisted	22.00
No. 18 cotton parallel	19.80
No. 16 cotton parallel	25.75
No. 18 cotton reinforced heavy	30.00
No. 16 cotton reinforced heavy	36.50
No. 18 cotton reinforced light	23.40
No. 16 cotton reinforced light	27.50
No. 18 cotton Canvasite cord	26.00
No. 16 cotton Canvasite cord	28.50

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.25
35-amp. to 60-amp.	100	.35
65-amp. to 100-amp.	50	.90
110-amp. to 200-amp.	25	2.00
225-amp. to 400-amp.	25	3.60
2-amp. to 600-amp.	10	5.50

600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	.40
35-amp. to 60-amp.	100	.60
65-amp. to 100-amp.	50	1.50
110-amp. to 200-amp.	25	2.50
225-amp. to 400-amp.	25	5.50
450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package 30%
1-5th to standard package 40%
Standard package 52%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$4.75 C
0-30 ampere, less than standard package	6.00 C

LAMPS—Below are present quotations in less than standard package quantities.

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B—Watts	Plain	Frosted	No. in Package	Mazda C—Watts	Clear	Frosted	No. in Package
10	$0.35	$0.38	100	75	$0.70	$0.75	50
15	.35	.38	100	100	1.10	1.15	24
25	.35	.38	100	150	1.65	1.70	24
40	.35	.38	100	200	2.20	2.27	24
50	.35	.38	100	300	3.25	3.35	24
60	.40	.45	100	400	4.30	4.45	12
100	.86	.92	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list

PLUGS, ATTACHMENT—

	Each
Hubbell, porcelain No. 5406, standard package 250	$0.24
Hubbell composition No. 5467, standard package 50	.32
Benjamin swivel No. 903, standard package 250	.20
Hubbell current taps No. 5638, standard package 50	.40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$12.00	$14.00	$13.90	$25.00
12	13.25	15.70	18.05	30.70
10	18.30	21.00	23.85	41.50
8	25.54	28.60	32.70	56.77
6	.....	.....	51.40	.....
4	.....	.....	70.00	.....
2	.....	.....	101.80	.....
1	.....	.....	131.86	.....
0	.....	.....	160.00	.....
00	.....	.....	193.50	.....
000	.....	.....	235.20	.....
0000	.....	.....	288.60	.....

Prices per 1000 ft. for Rubber-covered Wire in Following Cities:

	Denver—			St. Louis—			Birmingham*—		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$15.00	$16.00	$34.00	$16.00	$21.00	$33.00	$9.92	$15.25	$27.75
10	17.65	24.25	48.00	27.20	31.00	69.00	20.25	24.25	46.90
8	24.50	31.75	66.00	38.00	42.00	78.00	27.60	32.60	.....
6	38.65	42.25	.....	.....	65.00	130.00	48.25	54.75	.....
4	54.35	58.95	.....	.....	93.00	.....	66.90	73.75	.....
2	80.85	86.15	.....	.....	140.00	.....	96.00	104.50	.....
1	100.05	113.10	.....	.....	182.00	.....	121.00	136.40	.....
0	.....	158.00	.....	.....	242.00	.....	169.00	174.60	.....
00	.....	183.60	.....	.....	290.00	.....	203.50	214.00	.....
000	.....	222.80	.....	.....	360.00	.....	246.00	257.50	.....
0000	.....	269.70	.....	.....	435.00	.....	295.50	308.50	.....

Pittsburg—23c. base; discount 50% *June 1st prices.

SOCKETS, BRASS SHELL—

¼ In. or Pendant Cap.			¾ In. Cap		
Key, Each	Keyless, Each	Pull, Each	Key, Each	Keyless, Each	Pull, Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package +20%
1-5th to standard package +10%
Standard package −15%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B.&S. regular spools (approx. 8 lb.)	36c. lb.
No. 18 B.&S. regular 1-lb. coils	37c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 50c. lb., 100 lb. lots	48c. lb.
Rubber tape, ¾ in., less 100 lb., 65c. lb., 100 lb. lots	60c. lb.
Wire solder, less 100 lb. 50c. lb., 100 lb. lots	46c. lb.
Soldering paste, 2 oz. cans Nokorode	$1.20 doz.

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

30	.70	1.06	1.60	2.120
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.3
200	4.40	6.76	10.14	13.50

Discounts:

Less than $10.00 list value	+ 5%
$10 to $25 list value	— 8%
$25 to $50 list value	—15%
$50 to $200 list value	—20%
$200 list value or over	—25%